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Travel Booking Chatbot

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Resumo

Hoje em dia, os mercados de reservas de viagens online, encontram-se carregados de multiplas e diversas opções para o efeito. Este artigo, pretende concluir, se pode ou não ser útil recorrer a um agente virtual, também conhecido como chatbot, para complementar ou até mesmo substituir os motores de busca atuais, sendo capaz de proporcionar aos usuários uma experiência de reserva dinâmica e interativa, dentro de uma única janela de chat.
Na verdade, a ideia por de trás do uso de um chatbot neste processo, seria para o simplificar numa simples conversa entre usuário e máquina, tornando-o mais rápido e mais fácil do que navegar entre uma variedade de menus de um site. Deve ser bastante intuitivo de usar, permitindo que pessoas com menos conhecimentos de informática lidem com o processo, de uma forma que não seriam capazes recorrendo aos métodos tradicionais de marcação de viagens.
Para avaliar esta ideia, foi desenvolvido um protótipo de um chatbot, que permitiria aos usuários solicitar, via chat, a reserva de uma viagem para um destino específico, num período específico de tempo. Uma vez especificados os detalhes da viagem, o agente virtual procura voos, acomodações de hotel e também aluguer de carros, caso o usuário o deseje, exibindo as opções disponíveis mais adequadas, para que o usuário selecione uma delas.
Este protótipo foi testado por diferentes usuários, de modo a obter as suas opiniões sobre a sua usabilidade, tentando concluir se este método de reserva poderia ou não ser confiável, comparando esses resultados com outros obtidos através do uso de uma plataforma de reservas tradicional, em termos de velocidade, eficiência e preferências do usuários.

Abstract

Nowadays, there are plenty of online travel booking options, since the market is loaded with multiple travel search engines. This paper, aims to conclude, whether or not, it could be useful to complement, or even replace the more complex search engines, with a virtual agent, also known as a chatbot, capable of providing its users an interactive and dynamic booking experience, within a single chat room window.
In fact, the idea behind the use of a chatbot in this process, would be to simplify it into a simple conversation between user and machine, making it quicker and easier, than going through a variety of website menus. It should be very intuitive to use, allowing people with less computer knowledge to handle it ,in a way they would not be able to with the traditional methods.
In order to evaluate this idea, it was developed a chatbot prototype, which would allow its users to request, via chat conversation, the booking of a trip to a specific destination, in a specific period of time. Once the traveling details are specified, the virtual agent looks for flights, hotel accommodations and also car rentals, if desired by the consumer, displaying the best suited available options, for the user to select one from.
The purpose of this prototype, was to be tested among different users to retrieve their opinions about its usability, trying to conclude whether or not this booking method could be reliable, comparing those results with others obtained from the using of a traditional booking platform, in terms of speed, efficiency and user preference.

Agradecimentos

Queria agradecer em primeiro lugar à mimha familia por todo o apoio que me deu ao longo de toda a minha vida académica, aos meus colegas e amigos que apoiaram ao longo de todo este percurso e também à instituição que é a Faculdade de Engenharia da Universidade do Porto e todos os seus docentes que de algum modo participaram neste meu percurso, em particular todos os professores que me passaram o seu conhecimento ao longo destes 5 anos de carreira universitária. Relativamente ao desenvolvimento desta dissertação, gostaria de agradecer em particular à empresa que me acolheu para o desenvolvimento da mesma e a todos os seus membros que de certa forma me apoiaram no desenvolvimento deste projeto.

Pedro Lino

"Education Is Not the Learning of Facts, But the Training of the Mind To Think"

Albert Einstein

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Abbreviations and Symbols

API	*Application programming interface*
IT	*Information pechnology*
JSON	*JavaScript object notation*
NP	*Noun phrases*
PTP	*Peer-to-peer*
RS	*Recommender system*
UP	*User profiling*
VP	*Verb phrases*

Chapter 1

Introduction

When one considers going on a trip, whether it might be on business or leisure, most people tend to start an online search, perhaps on websites previously known or recommended by a friend. Truth be told, there are plenty search engines around the internet, and they all work pretty much the same way. The user looks for a place to input the travel data and then the website gathers a group of options to be presented. This entire process can be somewhat long and exhausting, specially considering that one might have to be going through multiple windows to finish it. The idea behind this project, would be to implement a system that would deal with the entire process in a single window, to make it faster and simpler, so everyone could easily do it, without any major concerns. The user would just have to chat with the virtual assistant and ask it to book the trip, which would be a much more intuitive process.

1.1 Context

Nowadays artificial intelligence technology is growing exponentially, being one of the main focus of researchers all around the world and with this sudden growth, it has unlocked a lot of new possibilities in terms of futuristic projects.
The basic concept of this one, is to create an agent able to give people a simpler and faster interface for trip booking. The big advantage of this solution, would be that they could have a more personal interaction with the software, being able to ask questions naturally, emulating a chat conversation with a real personal assistant. The goal is to gather all the things a traveler might need in just one platform, such as flight, hotel room and car rental. This way, the chatbot should interpret the sentences provided by the user and keep up with the flow of the conversation, generating an automatic response, such as a confirmation message, followed with another question asking for more relevant information, providing images and be ready to keep parallel conversations while keeping aware of the booking process' context.
As of today, the majority of people book their trips online, fact that can be supported by the big increase in booking search engines, appearing in the market. That being said, there are plenty of

similar booking platforms, but adding this chatbot feature would add a distinguish advantage in the market, since barely none of those engines uses a virtual agent to help their customers.

1.2 Motivation

On one hand,the artificial intelligence field is one of science most underdeveloped fields, but on the other hand, it is also one with the biggest potential, with limitless creation tools. This means, that besides being a big challenge, it can also provide big profits to those who can first take advantage of such a powerful tool.
About this paper's topic in particular, the majority of travel search engines, does not provide a virtual assistant, capable of giving the customer, the help this one might need, booking a trip. While for the younger generations, who grew up in technology-based environments, might be easy to use the search engines the market currently provides, a travel assistant could be very useful to those with less computer skills. Being that, this type of agent could be very helpful to people who are not very familiarized with software resources and would have trouble to navigate in complex menus to find what they are looking for, being that, this way, they could simply ask the agent to do it for them.

1.3 Goals

This thesis' focus is about implementing and testing a prototype of a chatbot for travel booking purposes. It should be able to answer different trip requests from many users and guide them through all the trip booking steps, in a series of textual messages exchanging between human and machine. The goal is to conclude whether or not, it could be a good alternative to the traditional travel booking methods, by running a series of tests comparing both alternatives' results.
More specifically, the chatbot should get information from the user, about when and where is the trip to be made, and find the best suited solutions in the internet about hotel, flights and car rental.
Overall, the testing procedures look to provide evidence to answer questions such as:

- Would a chatbot be ,in fact, be well received among older people?.
- Does the use of a chatbot translate in a simpler and more intuitive booking interface?
- Do their users feel limited, by the small amount of booking options provided by it?
- Using a chatbot would make a booking process faster?
- Would people be willing to exchange the traditional booking methods to use chatbot?

1.4 Document structure

This document is structured in 6 chapters, each describing a certain step to complete this dissertation. Beginning in the present chapter, here, the motives behind the elaboration of this study, are properly discussed and the goals for the studies to be made, are set. In chapter 2 there is a set of studies, about topics that are related to the main subject and somehow had its influence in the development of this paper. As for chapter 3, it approaches the methodologies behind the development of a proper chatbot, explaining how the process is done. On the other hand, chapter 4, refers how specifically this one was built, describing the technologies used to accomplish it and how they were used. Chapter 5, describes the testing process made on the prototype and discusses its results, analyzing their meaning. At last, in chapter 6, the conclusions regarding the entire process are stated.

Chapter 2

Related Work

In this section, areas related with chatbot and travel booking, work, will be approached, in a way that allows the reader, to get a better understanding about the current state of the technology itself and its current position in the global technology market. Firstly, it will be explained in what consists of a chatbot and what would actually take to built one, followed by an analyses into the travel booking market and the place of the chatbot in it.

2.1 The definition of chatbot

A chatbot, also referred to as virtual agent, or virtual assistant, is a conversational service built to provide its users an interactive online chatting experience, which aims to give them the perception of being chatting with another human being. It's a growing technology that is intended to be applied in many fields such as education, information retrieval, business, and e-commerce. Its purpose is to maintain a flow of conversation, while satisfying their users' requests. [4]
In fact, humans tend to prefer expressing their concerns towards other people, who could talk to them and help finding a solution, instead of trying to solve the problem alone and with the introduction of chatbots in online platforms, a lot of new opportunities emerge, since the clients could simply ask questions about the product, directly to the agent and get straight answers, establishing a line of conversation. [5]
Actually, as a technology based on artificial intelligence, chatbots are yet to develop their true potential, being still on early stages of their development. Although, one still tends to find more and more chatbots around the internet and the rising interest surrounding them, can be proven in figure 2.1, as the graph provided by Google Trends technology [6], shows a significant increase in Google searches containing the word chatbot, over the past five years.
Chatbots are not all the same, in fact, a distinction can be made in regard of their work method and subjects range. About the first topic, they can be classified as retrieval-based, or generative. As for their range, are divided in two classes, being those open domain and close domain. Following, the four definitions are briefly introduced.[1]

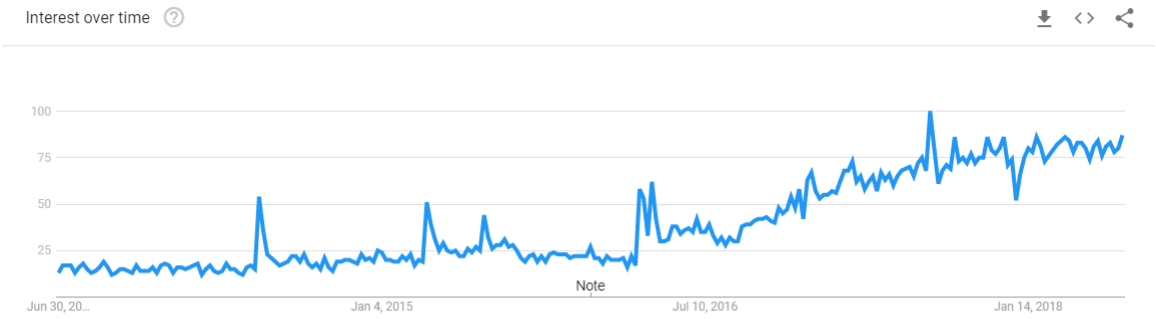


Figure 2.1: Increase in Google searches containing the word "chatbot", over the past 5 years.

- Retrieval-based: Every given answer is picked from a previously constituted set of answers and selected by a given set of rules, defined by an algorithm, depending on user input and conversation context.
- Generative: Resort to machine translating techniques to write answers from scratch, being that, are much more complex than the previous ones and require big amounts of training data to work properly.

Those from the first type of model are more reliable, since they don't make grammatical mistakes due to their default content, but on the other hand, the generative type are much more flexible, since they are able to handle previously unseen sentences.

- Closed domain: This kind of chatbots are only ready to talk about certain topics and will be lost, if any questions outside their field are asked.
- Open domain: Contrary to the previous, the open domain models are supposedly ready to argue about any subject with the user.

Ideally, every chatbot should be of type generative and work in open domain, but in fact, this kind is the most difficult to develop and science is still far from having a stable line of production for them. In figure 2.2, a table describing the different types of chatbots can be consulted. As the figure indicates, combining the two categories previously mentioned, leads to three distinct types of chatbots, being the ones from generative type more efficient that the retrieval. Although, for the prototype to be developed, will be used a closed domain and retrieval-based one, due to the amount of time and resources available.

2.2 Natural Language Processing

As previously acknowledged, virtual assistants should receive an input sentence from a user and interpret it, identifying what this one meant to say. The technology which allows the machines

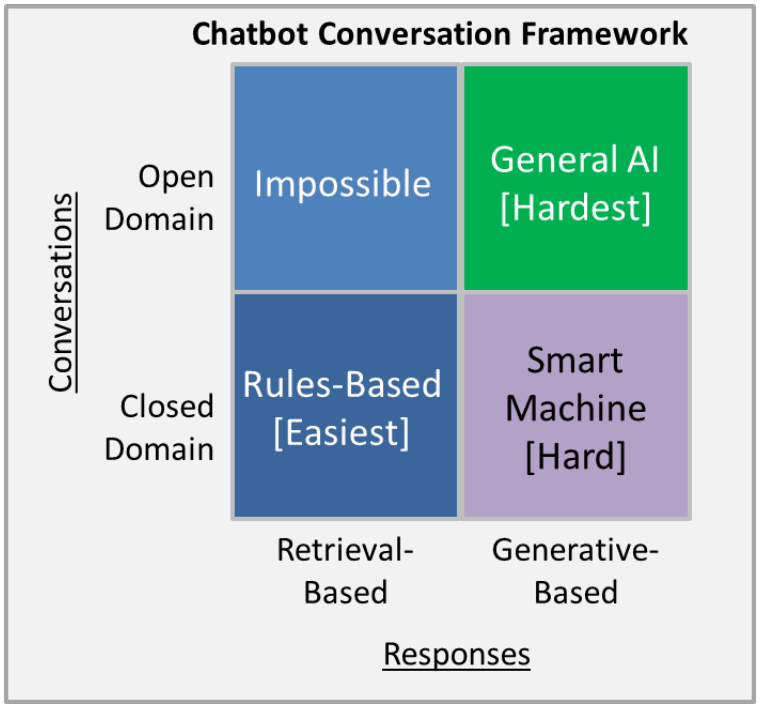


Figure 2.2: Comparison between different types of chatbots.[1]

to go through this process, of analyzing human language and retrieve a meaning out of what was said, is *Natural Language Processing*. [7]
NLP can be viewed, as the science that studies the way, computers can be used to understand and manipulate human language, either as a form of text or speech. One of its goals, is to study how humans understand and use their own language, so that, techniques for machines to interpret it can be developed, in order to allow the virtual agents, to understand the user's needs and become able to assist them in their tasks.[8]

NLP's methodology is about extracting simple representations that describe limited aspects of the textual information, being that, syntactic or semantic information. Its processes are based on labeling words into certain categories, so that machines can be ready to interpret them. In order to retrieve this information, some benchmarks regarding good NLP practices were developed. Among those are Part-Of-Speech Tagging, Chunking, Named Entity Recognition and Semantic Role Labeling.[9]

- Part-Of-Speech Tagging, is a process of labeling a word with a unique tag that indicates its syntactic role, finding whether it's a noun, adjective, verb, etc. and also if its singular or plural. The best POS classifiers are trained on windows of text, which are then inputted into a bidirectional decoding algorithm during inference. They analyze preceding and following word context, and multiple words (n-grams) context and specific proceedings to deal with unknown words(e.g. James [singular noun]likes [verb] apples [plural noun]).[10]

- Chunking, is about labeling parts of a sentence with syntactic constituents, such as noun phrases NP or verb phrases VP. Also, each word gets a unique tag, which can be either begin-chunk tag, or inside-chunk tag, indicating its place inside the original sentence (e.g. My big dog [B-NP] really likes [I-VP] chocolate cookies [I-NP]).[11]

- Named Entity Recognition,names atomic elements in the sentence into categories such as "PERSON" or "LOCATION".In this task, each word is assigned a tag prefixed by an indicator of the beginning or the inside of an entity, as well as in the previous one.[12]

- Semantic Role Labeling, gives a semantic role to the semantic constituents of a phrase, regarding to its predicate, being that, in case a sentence is composed of multiple verbs, some of its members can have multiple tags associated to them. It assigns different tags to the many components of a sentence. The tags vary from naming general arguments ARGn, being the order in which they appear towards the verb, but could also name a type of meaning such as location or temporal.(e.g. Last night [ARGM-TMP] Mary [ARG0] ate [REL] an ice cream[ARG1] by the beach [ARGM-LOC]).[13]

All the above concepts, represent theoretical processes of retrieving information from natural language and label it in a way that, it could be processed by computers. In order to actually obtain results, implementing those proceedings, one must resort to machine learning techniques based on statistical analyses and classification algorithms, to convert the input data into labelled segments. These approaches' efficiency is measured regarding their results' accuracy, when processed lots of training data. [9]

2.3 Travel booking trends

Actually, to verify whether or not, the inclusion of chatbot technology, would fit well in the travel booking market, is necessary to firstly study the current state of the market itself, checking its current needs and trends, to question how could this new booking approach add commercial value to it. In the following sections, different aspects of the travel industry will be briefly discussed.

2.3.1 Price and ratings influence over bookings

While designing a chatbot, one factor to take into account is the limited amount of information, able to be displayed in the chat window describing its travelling related products. In other words, when choosing travel amenities, the users will not have available as much information as they would in a typical website, so the goal here, is to find out if specific limited amounts of information could lean them to take decisions.
With that in mind, the point here, is to look for data that could support the premise that, small pieces of information would be enough to provide users evidence, that would allow them to make

decisions, regarding the choice of one option among a certain group. To accomplish that, the study conducted in [14] was used as a reference, aiming to conclude how simple, yet objective, details as prices or user reviews, could influence consumers' purchase decisions.
Effectively, the study in question was centered around finding how hotel prices and average star ratings, would affect its online sales. For that, they studied a high number of effective bookings and related them to their respective details, applying a mathematical model that would allow them to identify patterns among them. After results analysis the conclusion they retrieved were as follows:

- Higher prices effectively decrease hotel room bookings.
- When there is a significant gap between hotel room reviews, clients are willing to book the more expensive ones.
- Average ratings, not only are usually accurate and reflect hotels true value, but also have a real impact in users choices.
- A substantial quantity of consistent user comments, on a certain hotel, usually has an even bigger influence on customers, than its average ratings.

All things considered, the results provided by that study, indicate that details, such as price or ratings, which are easily inserted in a chat layout, can give users a good perception of what they are buying. Nevertheless, a comments section, that would also be a good indicator for the users, could be somewhat difficult to insert in a chatbot, since it would consume a lot of space.

2.3.2 Mobile booking and keys to a reliable booking platform

Generally speaking, the travel market, such as any considerable market, has gained an entire new dimension with the exponential growth of the internet, over the past two decades, which means not only that, to search for and book a trip had never been easier, but also that competition inside the market is very high and to establish a new service among it can be a tough task. In addition to that, it's safe to say that in recent years, the mobile technology market, has been taking over, being that, nowadays nearly every activity that was only possible via computer, is now available anywhere in a mobile device, due to the big advances and investments made in the smart-phone industry. Moreover, in figure 2.3, there is a graph representing statistical data gathered, until 2017 in the United States of America, comparing the evolution of mobile and desktop travel booking, over the last couple of years and predicting the evolution for the next few[2]. Significantly, not only is confirmed that the numbered of trips booked online are increasing considerably, but also that mobile booking is establishing itself in the market, gaining more popularity as the years go by.
Provided that, in regards of mobile travel booking, the article [14], conducted a study regarding the most important aspects, that made people starting and continue to use a certain mobile platform to book their trips, being its most notable conclusion as listed:

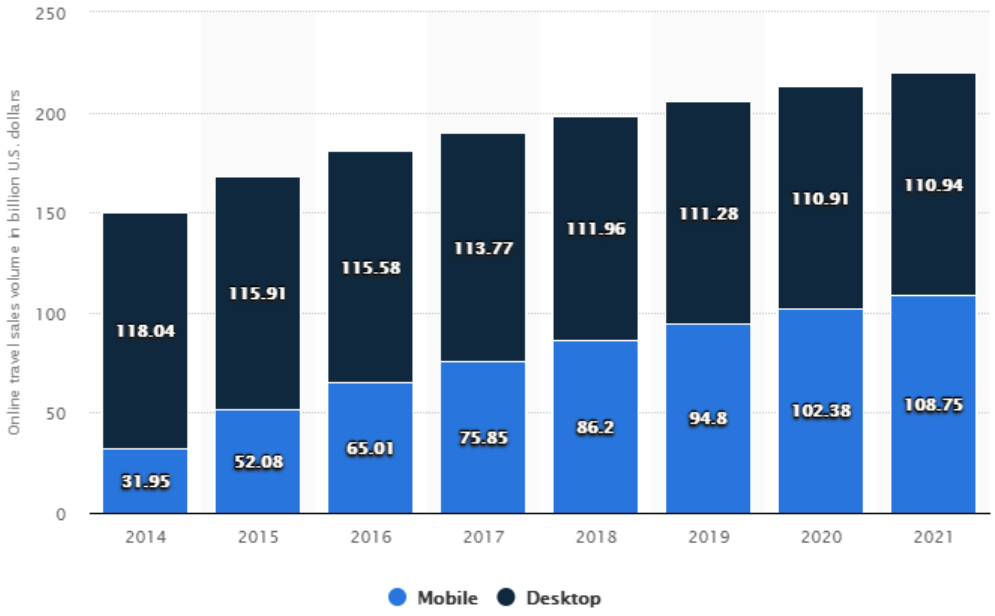


Figure 2.3: Digital travel sales in the United States from 2014 to 2021, by channel (in billion U.S. dollars).[2]

- The two factors that impact the returning of a customer to a booking service the most, are its usefulness and the way it satisfies the clients' needs.
- One major influence in customers' satisfaction, is the meeting of their expectations, particularly those set in advertisement, stating that "higher expectation and poor performance, will play a negative impact on clients".
- A big percentage of a certain service's customers, come from direct recommendations from friends, highlighting the importance of customer satisfaction.
- Users tend to look for simple systems, the easier to handle one is, the greater the likelihood of a customer going back to using it.

With that being said and acknowledging the increasing trends in mobile trip booking, which point to the success of the chatbot's insertion in the market, since it would be fairly easy to interact with, as it would work as a simple process based on quick messaging exchange, which is certainly simpler than navigating through an application's menus, looking for content. It could also be referenced, that user satisfaction plays a crucial role in online booking services, being that, one major consideration to have while building a new system with that purpose, would be to set realistic goals, culminating in the development of a user friendly, easy to use system.

2.3.3 Emerge of peer-to-peer accommodations

Another area of travel booking that has been emerging in the recent past, is the PTP accommodation renting. Growing as a big competitor to hotels or vacation villages, local home rental has

undoubtedly not only entered, but also extended the market in full effect, which opens a ton of new possibilities for tourism.
In fact in [15] , a study was conducted regarding the changes it caused in travelers' behavior and its impact on tourism destinations. After a series of surveys and pattern analyses, it came to conclude that, the main reasons that made local house renting so popular was due to the fact of its competitive prices and the opportunity it gives tourists to feel more integrated into the local communities. It was also acknowledged, that this emerging trend has been expanding the variety of cities travelers opt to travel to, due to the fact that it gives them a much easier access to cities that would, otherwise not have much offer, like places in which its demographic conditions wouldn't appeal to the construction of hotels.
All this factors, have been leading to an increase in the number of travels made per year, which opens more space in the market for chatbots, to potentially take advantage of .

2.4 Recommender systems

Firstly, when looking to book a new trip, a user can find a lot of unnecessary information all over the internet, whereby resorting to a chatbot, that problem should be solved, since the virtual agent would search around the web and gather a small group of options that would be of the user's interest. In view of designing an efficient chatbot, one should try to ensure that it presents its users, with the travel options most suited to their needs. Having said that, the way of looking to gather a group of options most appropriated to a certain user, is based on recommender systems.
Then again, RSs are programs consisted of techniques which aim to provide an user, groups of suggestions regarding certain items, selecting the ones considered of being of the most interest, towards the user in question. The process is about ranking items through specific sorting algorithms, that receive users' preferences and constraints as inputs, preferences which could either be, indicated by the own users, or inferred by interpreting the history of each user's actions. These recommendations, could also come related with choices made by users with similar profiles, or who made similar choices in the past, in a way of associating the recent choices made by people with the same tastes. These information was retrieved based on the article [16], which then stated that, "In recent years, RSs have proven to be a valuable means of coping with the information overload problem".
To give an illustration, a good solution for improving a reccomender system, to be incorporated in the chatbot, would be to ask users to register personal profiles onto the system, where they would fill some travel preferences, as budgets, preferable accommodations or even, usual flight schedules. These details would be great indicators in helping filtering the results from the searching process.
Additionally, a chatbot could also benefit, from the inclusion of a RS regarding local tourism activities, in a way that, in the middle of a conversation,the agent would easily suggest some activities for the client to do, at the destination where the trip was to be booked. With that in mind and as mentioned in [17], the chatbot would benefit from the RS, gathering a set of activities to be

Name	Description
Text tracing	Moving the mouse pointer along a sentence while reading
Link pointing	Positioning the mouse pointer on a link, but not clicking the link.
Link clicking	Clicking on a link to move to another page.
Text selection	Selecting text by dragging the mouse pointer.
Scrolling	Scrolling a window at a certain speed.
Bookmark registration	Registering a page as a bookmark.
Saving	Saving an HTML document.
Printing	Printing a page.
Window movement	Moving a window of the Web browser.
Window resizing	Changing the window size of the Web browser.

Table 2.1: User profiling techniques

suggested to the user, in a way of easing the information that would be presented in a regular search process, while persuading the client of the appropriateness of certain proposed services. This feature could not only enrich the functionalities of the virtual assistance, but also provide some business relationships with certain commodities to be suggested to the clients.
Moreover, a modern technique which RSs rely on, to gather more information about its users, is *User Profiling*. This process consists in creating a digital profile for each user, where its habits and tastes are described. LP will continuously update its profiles, through user behavior analysis. To collect such information, certain operations to monitor user activity were developed, being some of those represented in table 2.1.[18]

Chapter 3

Project Specification

This chapter approaches the different methods used to build a prototype of a travel booking chatbot. It covers the variety of areas involved in the process, while describing its architecture and the integration between every one of its components.

3.1 System architecture

The system can be separated into three distinct parts. The first one consists in securing a reliable line of communication between human and machine. To accomplish that, the messages sent by the user, must be processed in a way that, they become readable by the machine. Once the program is able to interpret sentences, it must question itself, what was the intent behind the textual exchange and act according to its meaning. Finally, it should be connected to external APIs to gather the data it might need, to fulfill its users' requests. Throughout this chapter, the architecture will be described in more detail.

3.1.1 Natural language interpretation

Generally, chatbots can be used to solve a large variety of problems, depending on the environment they are inserted. In this particular case, one's services would be required to deal with travel logistic issues. No matter what the field of action might be, they all must take an essential step to reach its goals, which is to receive an input from a conversation and extract something meaningful out of it, in a way that, an appropriate context-sensitive answer can be generated. To achieve this, it's necessary to convert the natural language given from the user, into machine language, understandable to the agent.

To deal with this problem, one could opt from one of two solutions, either develop a NLP classification system from scratch, or use a bot building framework. The big advantage of opting with the first option, would be to have much more control over the system to be developed, in terms of not being limited by a framework's general structure and being able to adapt the code to fit the specific needs of the product to be developed. However, since the scope of this thesis is to asses the application of chatbots in solving the issues of travel logistics, developing an NLP classification

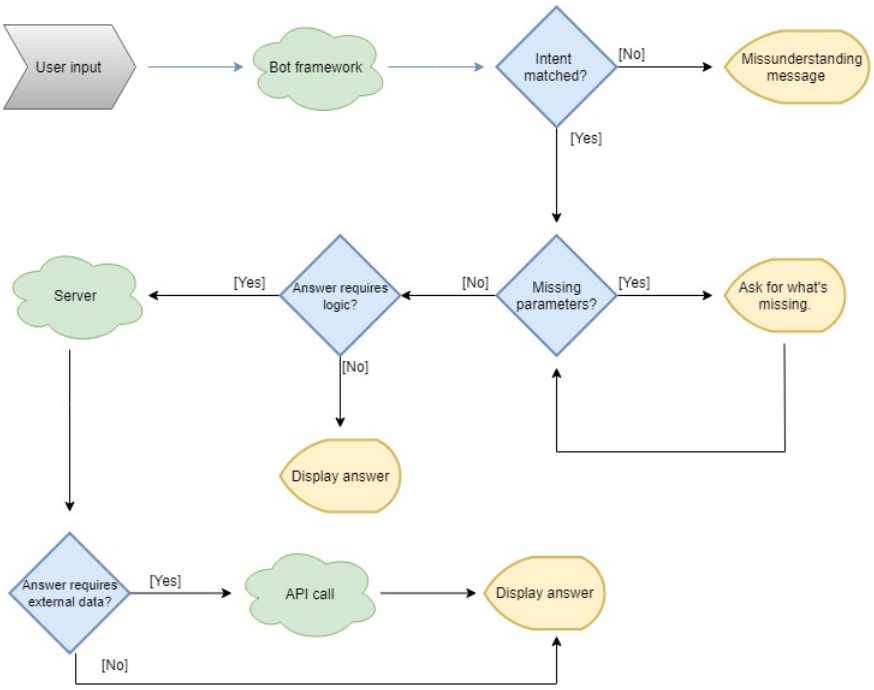


Figure 3.1: Message processing architecture.

module from the ground up would be counter-productive.

As previously stated, the bot framework's goal is to translate human natural language into machine language. In a sentence such as : "I want to book a trip to Madrid for 5 people", the tool should be trained in such a way that it would identify, not only that the user's intent is to start booking a new trip, but also recognize parameters such as the destination and the number of people the trip is for, while inferring omitted parameters, such as departure date and location.

This tool works based on NLP algorithms that allow the programmer to train their virtual agents in any areas of their choice. The training process relies on the programmer, to insert big amounts of data into the chatbot, allowing the framework to recognize patterns among the training examples, that would, ultimately, allow the system to form the shape of intents.

As mentioned above, the agent's behavior centers around intents, which guide the it through what the user pretends to do or know, based on what this one said to it. Other particular important aspect of the system are contexts, that allow the agent to understand the point where a conversation is, at a certain moment in time. These two are related to each other, as an intent will only be triggered if certain contexts are currently active, giving the system a state-machine like architecture.

Once an intent is successfully identified by the agent, it will then proceed to present one from many possible, previously programmed answers. In case it's a simple answer, such as, asking the agent's name, it is automatically ready to answer, but in case the triggered intent, is more complicated than that and requires a more complex business logic, the bot framework will then have to communicate with the server and, perhaps, with external APIs to retrieve the information the client asked for. This process is described in figure 3.1.

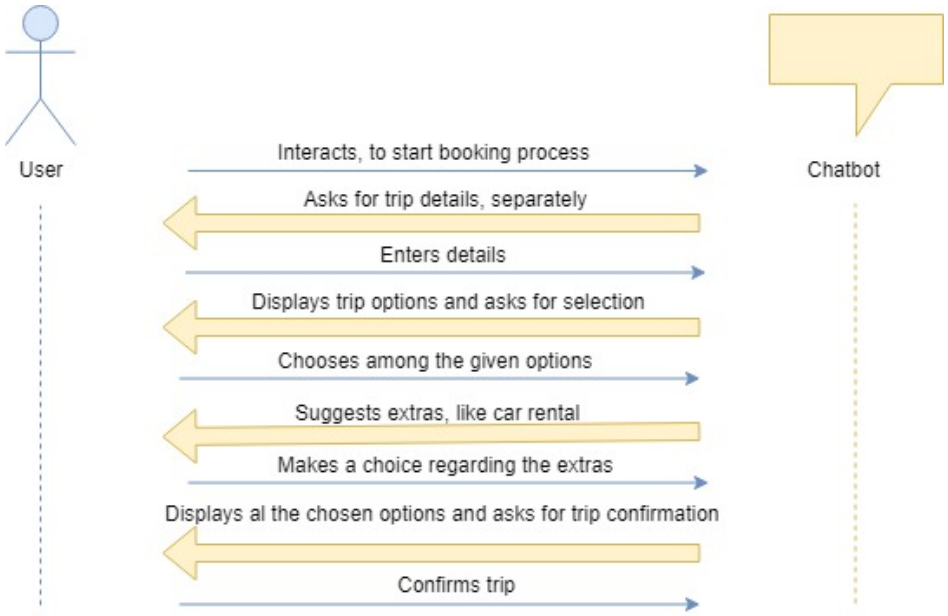


Figure 3.2: Conversation flow structure.

3.1.2 Business logic

Once the syntactic analyses are done, the machine can have a clarified idea of what the user meant, in the last interaction they had. Following, in terms of preparing a chatbot to serve a specific purpose, in this case, to help customers booking their travels, this one must incorporate all the necessary steps to pursue that objective, well established within its code, in a way that, it would instantly recognize what to do, in case the user shows any intents that would trigger certain actions, within its line of business.

In fact, the machine should be programmed, to be able to guide its users through all the necessary steps to complete the final goal, always being one step ahead, asking for information, in a way that, the user doesn't need to take initiative and is allowed to feel more comfortable, being guided by the system. Actually, the chatbot should also be programmed to keep the flow of conversation in a close loop, asking straight questions, so that the user answers intuitively and doesn't take the conversation to areas where the bot would not be prepared to answer. In figure 3.2, there is an example of how a conversation should be structured, by having the virtual agent taking the lead, in regards to the booking process.

That being said, there's still the need to prepare the chatbot to execute the variety of actions required to fulfill its mission. For that, there must be a server coding every action, that the bot framework can not answer by itself, which will mostly involve communication with external databases to retrieve data of actual flights and travel accommodations. In this particular case, the business logic regarding the server, will be mostly, presenting the clients travelling solutions and save their selections for post-selection confirmation. At last, it's key to incorporate safe communications either with the bot framework and the external APIs that will perform the real time destination searches.

3.1.3 External data processing

As previously stated, to fully fulfill the purpose of a travel booking chatbot, it must provide the user with actual travel assets, that this one might opt to book or not. In order to obtain that, the server program must reach outside applications that provide those type of services. In most cases, these APIs provide excessive amounts of data and depending on the kind of application to be built, not every part of that data can be useful, being that, a selection of its key parts must be done, in order to present it to the user in a smooth and easily understandable kind of way.
Majorly, the data providers are usually big travel companies, well established in the market, with big investments in the sector, that make a business with up and coming new clients, who are open to pay a certain amount to get access to their data. On the other hand, there are also smaller non-profit organization that allow users to get access to the data they organize for free, being that, most either ask for a donation, or request the customers to get premium status, to get access to a certain level of requests per period of time.

Chapter 4

Prototype Implementation

In the next few pages, the implementation process of the developed chatbot prototype, will be detailed. The technologies used to accomplish it, will be named and the part they took in the project, will be explained. Some examples and code extracts will also be available, for a better overall perception of the entire process.

4.1 Dialogflow

Nowadays, there are plenty of bot frameworks to choose from, being that, the choosing criteria depends on each developer's personal criteria, since they are similar among each other. The most recognizable frameworks are those currently backed up by the largest technology companies, such as Microsoft Bot Framework [19], Dialogflow (Google) [20], Wit.ai (Facebook), IBM Watson [21] and Amazon Lex [22]. To carry out this prototype , it was used Dialogflow, due to its wide range of functions, intuitive interface and easy integration in a variety of chatting platforms.
Actually, this system's purpose is to create agents, whose goal is to receive input messages from a user, identify their meaning and process them, to later return an appropriate answer. Once an input is entered, it will be interpreted by the NLP logic and its key parameters will be identified, what may lead to the recognition of a known intent, or failure to do so, which would lead to the default fallback intent, which is basically, the agent telling the user it didn't understand what this one just said. If an intent is recognized by the agent, either an immediate response will be generated, or the retrieved parameters will be sent to the webhook server, where the business logic is processed and if necessary,the server will also interact with additional APIs or databases, to retrieve information required by the user. This entire process can be observed in figure 4.1.

4.1.1 Training process

First of all, to achieve a virtual agent capable of understanding and speaking English, it must first be trained to do so. Dialogflow is the tool that allows one to train an agent, preparing it for specific conversation topics.
In fact, the agent's behavior will be structured, based on contexts and intents. For every action the

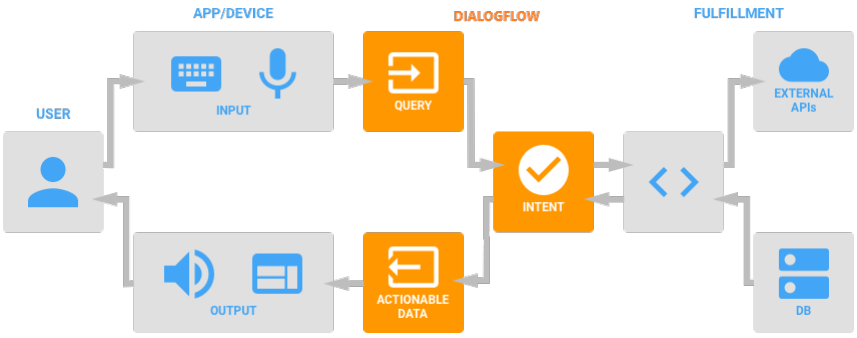


Figure 4.1: Dialogflow architecture.

agent is expected to do, there has to be an intent triggered by the user, through the messages sent in the chat. An intent is defined by key words that identify it and also parameters that change its properties, depending on the variety of inputs coming from the user.
Nevertheless, to teach the agent a new intent, one must provide it with several examples of training phrases, that mean to represent it. That being said, dialogflow's natural language processing algorithms, will analyze the provided example sentences, identifying them and creating patterns that will represent the intent to be executed. Briefly, the agent's developer has to introduce through dialogflow, the variety of ways that the agent should expect to detect each intent. With that in mind, while training for a certain intent, the developer has to properly define every parameter required, to process it correctly. In the example of booking a trip, the training process for that intent, must imply that the it requires at least the parameters for the destination and the dates of the trip, for its completion and while training the agent with a new sentence it's also necessary to mention which words refer to which parameters.

Exemplifying, the training process of the intent "trip.start" is shown in figure 4.2 One can notice the four parameters required to fulfill the intent: the destination, number of passengers check in date and check out date. In case dialogflow detects that the user sent a message, which triggers a certain intent, but also that one or more of its parameters are missing in the same sentence, the chatbot will request those missing parameters, to be able to proceed with the intent's action. To give an illustration, the intent displayed in the picture, could be recognized by a sentence as simple as, "I would like to book a trip", but then the chatbot response would be, to ask for each missing parameters in individual messages, until it has all the necessary data to process the action associated with the intent, which would in this case be, to look for trips regarding the given details.

4.1.2 Handling responses

When sending a message to a chatbot, there are two possible outcomes, either the message's structure is recognized and triggers a specific intent, or it is classified as unknown and triggers the default fallback intent. In case an intent is identified, the response depends on the type of intent in question.

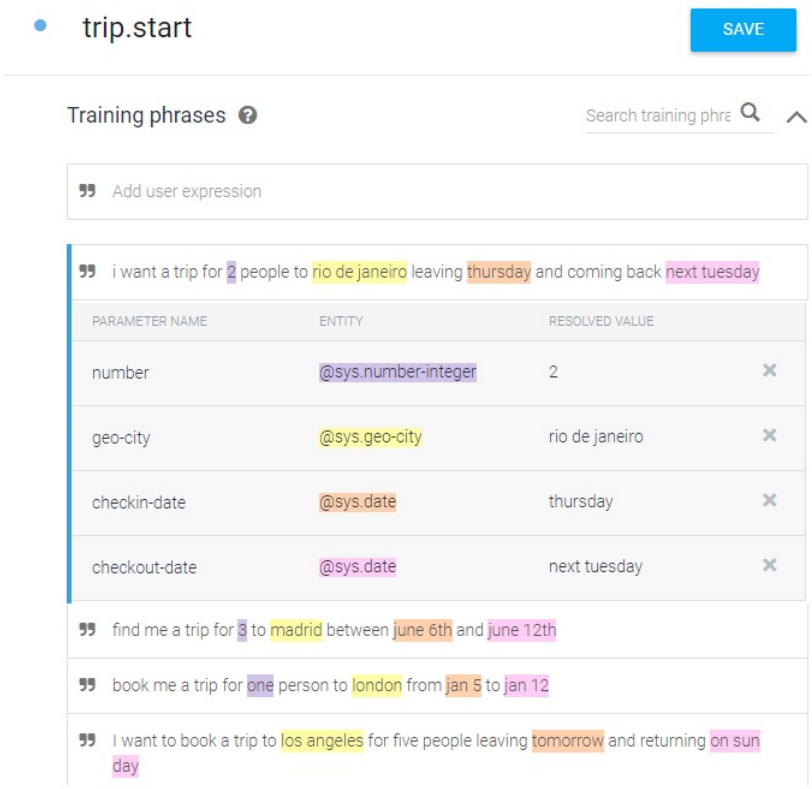


Figure 4.2: Example of the agent training for an intent.

For example, if the user greets the machine, it will simply reply back with a greeting message of its own. This quick response, will be selected from a group of default responses, which the bot has prepared for that intent.(e.g. "Hello, I am here to help you booking a trip."). Also, if an intent is matched, but dialogflow notices some of its required parameters are missing, the response given is a custom sentence asking the user, to input the missing data.
Otherwise, if the required answer is more complex than that and requires some business logic, like in case of looking for a new hotel, dialogflow will interact with the webhook server and this one will produce the answer, which will then be returned to the user.
At last, in case a user's sentence doesn't match any intent, dialogflow will trigger the default fallback intent, which an example of, can be seen in figure 4.3, that is basically a default set of answers, that the machine will display, if it didn't understand what the user meant to say.
Nevertheless, in dialogflow there is a relationship of dependency between contexts and intents, which means, that for an intent to be ready to be activated, the context or group of contexts, that allow it to be activated, must be already active, otherwise, even if a sentence that would normally trigger it is received, will be recognized by the agent as an unknown intent and trigger the default fallback intent. To be more specific, the user can write a sentence that would be the trigger for a particular intent and yet, still not trigger that intent. That could happen when the state of the conversation is not at a certain point, where the required contexts to make a certain intent available are active. The relation between intents and contexts and how they affect this system in particular,

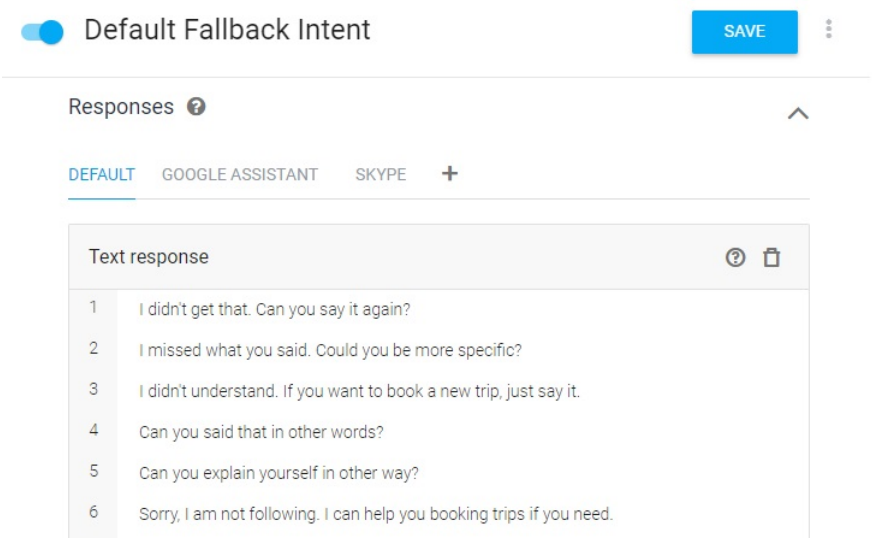


Figure 4.3: Fallback intent examples.

will be deepened in the next section.

4.1.3 Conversation flow

As previously acknowledged, for the agent to perform a reliable trip booking conversation, its intents should be well structured, following almost a unique path, that guides the user through the entire process, without allowing many chances for it to take alternative routes, in order to try that the human doesn't drive it to subjects, that the chatbot would not be prepared to talk about.

In figure 4.4, every major intent created for the booking process, is represented by a rectangle and mapped within the program's structure, followed and/or preceded by its related intents. Every one of them is represented by its name, followed by what the user would have to say, in order to trigger it and consequently make the intents that follow it, active. More specifically, what makes an intent active are the system variables as dialogflow refers to as contexts, being that, each intent needs to have certain contexts active to be able to become itself active and will also activate certain contexts, once is triggered, which is what allows the intents that follow to become active and forming this way, the structure of contexts and intents represented in the figure. Specifying, taking a better look at the diagram, if the intent named "Select flight" becomes active, once the user types a message selecting one of the flight options displayed (condition to surpass this intent), it will make the intents "Confirm flight" and "Reject flight" active.
Reinforcing this idea, contexts dictate whether or not, some intents are able to be activated since that, when an intent is executed, it may activate new contexts, but also may deactivate some other, meaning that, intents and contexts have a relation of dependency between each other. This point is illustrated in the figure, since looking at both the intents "Confirm flight" and "Confirm hotel", the two need an affirmative answer from the user (e.g. yes, sure, ...), to activate the intent that follows, but what differentiates which intent will activate the next intent to itself, is the current active contexts of conversation. In other words, if a context called, for example, "booking hotel"

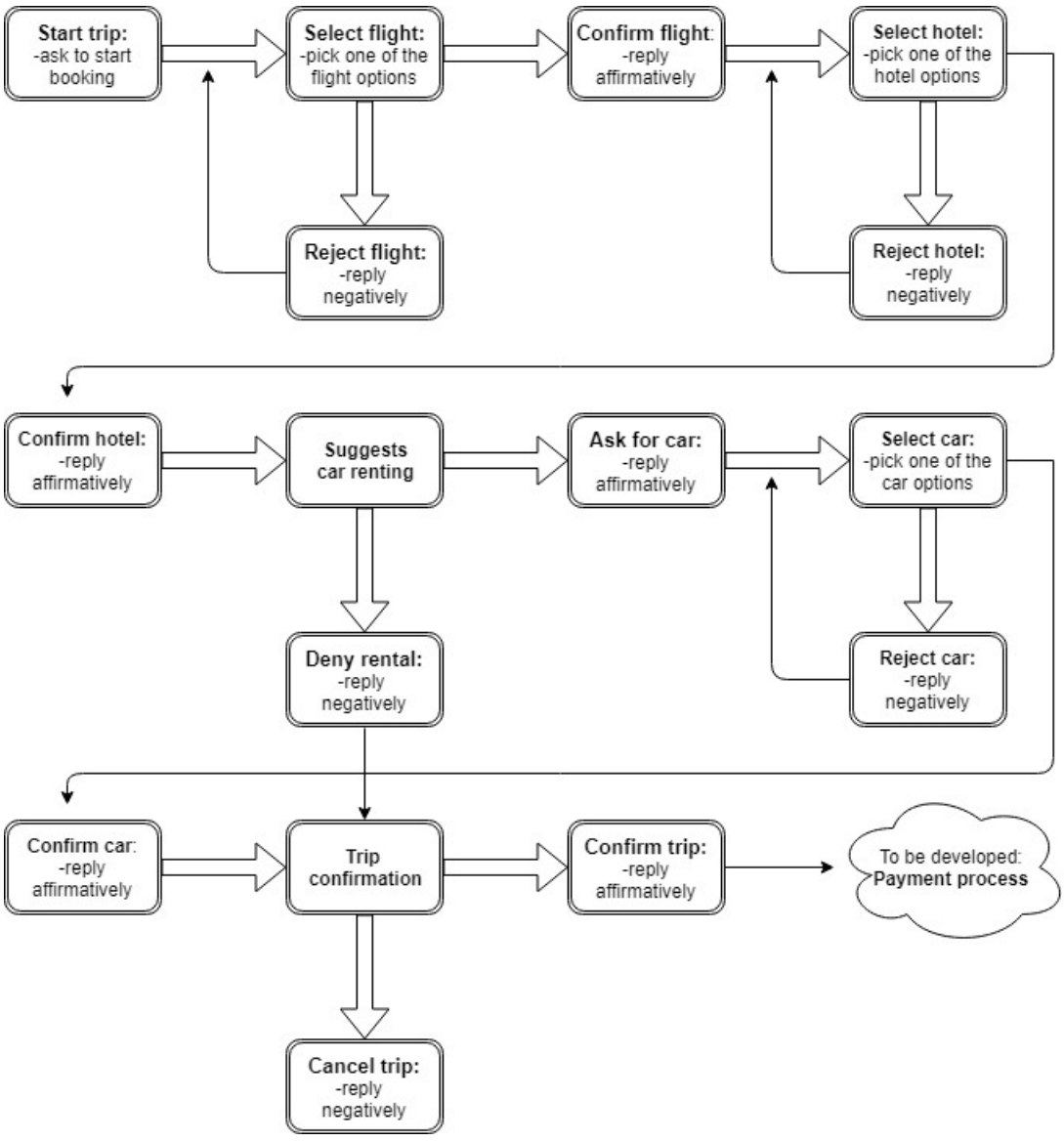


Figure 4.4: Structure of conversation states.

were active, it would indicate to the program, that the active intent would be "Select hotel", instead of the other intent, which is triggered by the same user sentences, but whose contexts are not active at the moment.
Analyzing the figure in detail, the process starts with the "Start trip" intent, which requires no previous contexts to be activated and indicates the beginning of a new booking, followed by three similar steps which are, booking the flight, hotel and car. The three are similar, because they share the same structure. First a range of options is shown to the user, among which, this one has to choose one from, then the option is highlighted, to be confirmed or rejected, being that, in case of rejection, the program displays the options menu again, for a new choice to be made and in case of acceptance, the system saves the option and moves on to the next phase of the booking plan. After picking the flight, hotel and car, the system shows the three selected options once more and asks for a final confirmation from the user, to make sure everything is correct. In case a negative answer is received, it would cancel the trip, but in case of an affirmative one, it would proceed to the payment process, phase which was not approached in this dissertation, but could easily be incorporated in a similar chatbot prototype.

4.2 Webhook server

The webhook server is the unit responsible for handling the POST requests, coming from dialogflow. Its function is to be actively waiting for a new interaction from the bot framework and handle it according to its content. Here, is where every action will be programmed, which means, when dialogflow detects a certain intent, that requires external processing, it sends the request to the webhook, that will then identify the intent and its corresponding parameters and act according to its code, returning an appropriate response.

4.2.1 Technologies used

The core of the server was programmed in javascript, since that dialogflow provides its data in JSON format and also most booking APIs provide their data in this format as well, javascript seemed the most appropriate choice.
In the same way, to execute the server's code, was resorted to node.js [23], which is one of the most popular JavaScript run-time environments, available in the market. It doesn't require the use of threads and offers well scalable servers, resorting to event-driven coding, based on callbacks.
To do the deployment of the server, were used the services of ngrok [24], which is a platform than allows to deploy a webhook for free. The downside of it, is that the free version only stays live for 8 hours and, after that, there is the need to run it again and every time it runs, it is located at a different address that needs to by manually updated in dialogflow's configuration ,so that the connection can be properly reestablished.

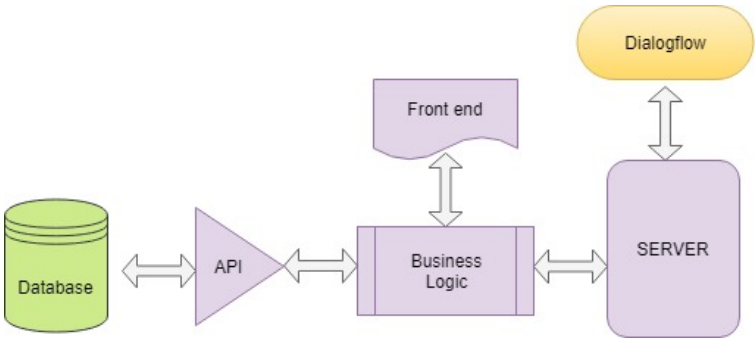


Figure 4.5: Components layout scheme.

4.2.2 Code structure

As to the code itself, it is divided in modules, having its layout as illustrated in figure 4.5. Although it will not be explained in detail, following there is a brief description of the entire structure and explanation about how its different components relate to each other:

- Main module- Where the server runs and keeps on waiting for new POST requests, coming from dialogflow. Once a new request arrives it is tested in a switch statement and in case it matches any defined action, the program will call its module and execute the appropriate function.

- Business modules- There are three modules one for each travel segment, being those, flight, hotel, and car booking. Each one of the three modules, is called from the main module on separate two occasions, first to prepare the array of booking options, where the client will choose an option from and secondly to highlight the option chosen before, in order to ask for confirmation from the user.
  Each module is coded in its own way, since there are plenty of differences regarding the product they work with, meaning, the flights, hotels, or cars, in a way that, there are certain aspects of the different types of data, that have to be processed in their own ways, needing different functions to deal with each one. With that being said, the structure of the three modules is yet similar, since they all receive input parameters in a JSON format, coming from dialogflow, which will be processed and stored in memory, to then be sent to the API modules, that will return its own data, also in a JSON format, which will again, need to be processed and stored in memory, to at last, be sent to the front end modules, that will convert that data into displayable cards, which the business modules, will finally return to the main module, who asked for them in the first place.

- API modules- There are three modules as well, one for each component. Each receives data from the respective business module and uses it as parameters for the GET request, to be sent to the travel API. There is the need for three different modules because, although the requests are done in the same way, the required parameters vary from one to the others.

```
const fetch = require("node-fetch");


module.exports = {

    loadDoc: function loadDoc(location,checkin_date, checkout_date, api) {
        var url = "https://api.sandbox.amadeus.com/v1.2/cars/search-airport?apikey="+api+"&currency=EUR&location="
        +location+"&pick_up="+checkin_date+"&drop_off="+checkout_date;

        return fetch(url, {
            method: 'get',
        });
    }
}
```

Figure 4.6: Example code of how to make a GET request with Sandbox.

- Front-end modules- Here is where the cards with the product's information are designed. The modules are composed by a preset architecture, that will be filled with the retrieved data, from each new trip search made. In the flights card, there is information about both outbound and inbound flights, regarding time, location and prices. As for the hotels card, information about the name, location, price and amenities of the same, is displayed in it, followed by a picture describing the facility. At last, for the car rental, there is the name of the car renting company, the price of the rental and the type of car in question.

4.2.3 Obtaining external data

The platform used to retrieve travel data from, was Amadeus Travel Innovation Sandbox [25]. In fact, there are many different platforms that offer this kind of services, from global travel agencies, to open-source platforms, developed by small groups of people. After some looking around the internet, this seemed to be a very good fit to this prototype, since it allows its users to create accounts and use the service freely for one month and then, in case of wanting to expand it into an actual business, pay them a certain fee. Alternately, other platforms either required permissions or fees to obtain their services, or didn't offer a very good product. The only downside of using the Amadeus' one, was having to create a new account monthly, to remain with a free membership access, for this non profit prototype, otherwise, its interface was very intuitive and the information available was very complete and reliable.
To execute an API call, was used node package "node-fetch", which allows to make network based on promises, avoiding more callbacks, that could possibly cause resource conflicts. In figure 4.6, there is an example of how to make a call to sandbox, from the webhook's car API module. After its execution, the request will provide a response in a JSON format, as the one available next, in 4.1.

Listing 4.1: Example of a flight request response from Sandbox


```
{
  "currency": "EUR",
  "results": [
    {
      "itineraries": [
```

```
{
  "outbound": {
    "duration": "22:45",
    "flights": [
      {
        "departs_at": "2018-09-23T20:35",
        "arrives_at": "2018-09-23T22:45",
        "origin": {
          "airport": "OPO"
        },
        "destination": {
          "airport": "MAD",
          "terminal": "4"
        },
        "marketing_airline": "IB",
        "operating_airline": "IB",
        "flight_number": "3097",
        "aircraft": "32A",
        "booking_info": {
          "travel_class": "ECONOMY",
          "booking_code": "S",
          "seats_remaining": 9
        }
      },
      {
        "departs_at": "2018-09-24T12:10",
        "arrives_at": "2018-09-24T14:20",
        "origin": {
          "airport": "MAD",
          "terminal": "4S"
        },
        "destination": {
          "airport": "JFK",
          "terminal": "7"
        },
        "marketing_airline": "AA",
        "operating_airline": "IB",
        "flight_number": "8645",
        "aircraft": "359",
        "booking_info": {
```

```
            "travel_class": "ECONOMY",
            "booking_code": "S",
            "seats_remaining": 7
          }
        }
      ]
    },
    "inbound": {
      "duration": "10:00",
      "flights": [
        {
          "departs_at": "2018-09-29T20:50",
          "arrives_at": "2018-09-30T10:05",
          "origin": {
            "airport": "JFK",
            "terminal": "7"
          },
          "destination": {
            "airport": "MAD",
            "terminal": "4S"
          },
          "marketing_airline": "AA",
          "operating_airline": "IB",
          "flight_number": "8646",
          "aircraft": "359",
          "booking_info": {
            "travel_class": "ECONOMY",
            "booking_code": "S",
            "seats_remaining": 7
          }
        },
        {
          "departs_at": "2018-09-30T11:35",
          "arrives_at": "2018-09-30T11:50",
          "origin": {
            "airport": "MAD",
            "terminal": "4"
          },
          "destination": {
            "airport": "OPO"
```

```
                    },
                    "marketing_airline": "AA",
                    "operating_airline": "IB",
                    "flight_number": "8795",
                    "aircraft": "319",
                    "booking_info": {
                      "travel_class": "ECONOMY",
                      "booking_code": "S",
                      "seats_remaining": 7
                    }
                  }
                ]
              }
            }
          ],
          "fare": {
            "total_price": "412.44",
            "price_per_adult": {
              "total_fare": "412.44",
              "tax": "283.44"
            },
            "restrictions": {
              "refundable": false,
              "change_penalties": true
            }
          }
        }
      ]
    }
```


4.3 Final product

4.3.1 User interface

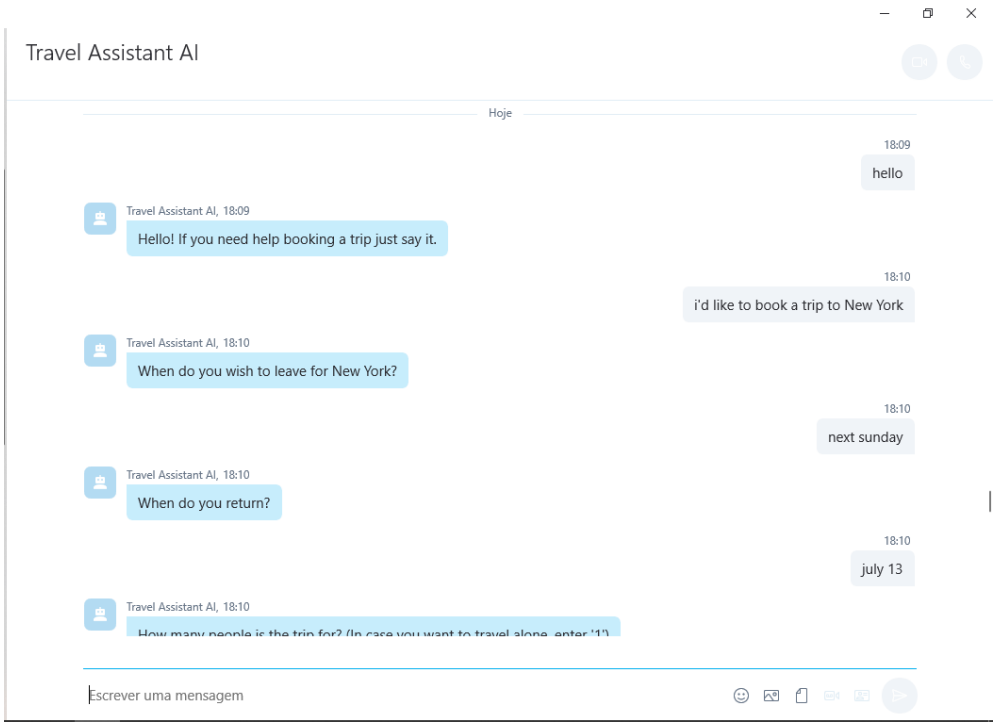
After getting through the language barriers and the server requests, there was still the need, to supply the users, a proper point of access to the chatbot itself. In fact, to do so was very intuitive, since dialogflow has services that allow its developers to integrate their virtual agents directly with tons of popular text interchange platforms, like Facebook Messenger, Slack or Twitter. For a matter of simplicity, to pursue this prototype, the chosen platform was Skype. The integration with Skype, only required the registration of the bot into the Microsoft bot framework and also

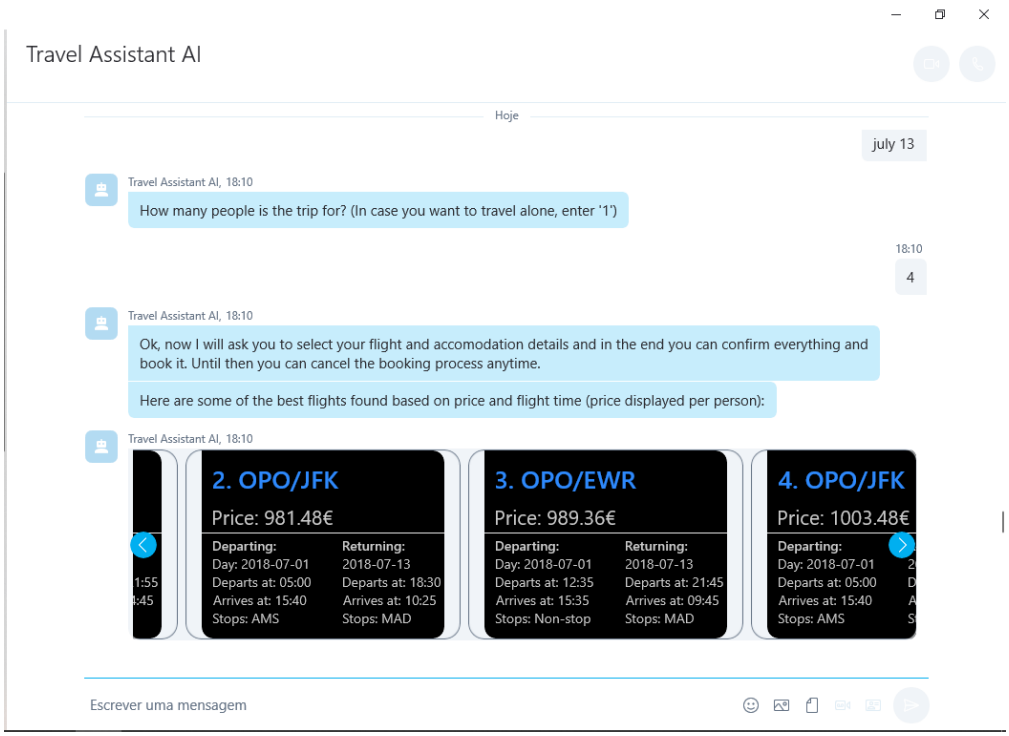
brought the advantage of having some preset cards, which could be configured, to display the travel information in the chat room, with an appropriate and clean layout. Using skype to interact with the program, also provided the advantage of being able to run the chatbot either in desktop, or mobile devices.

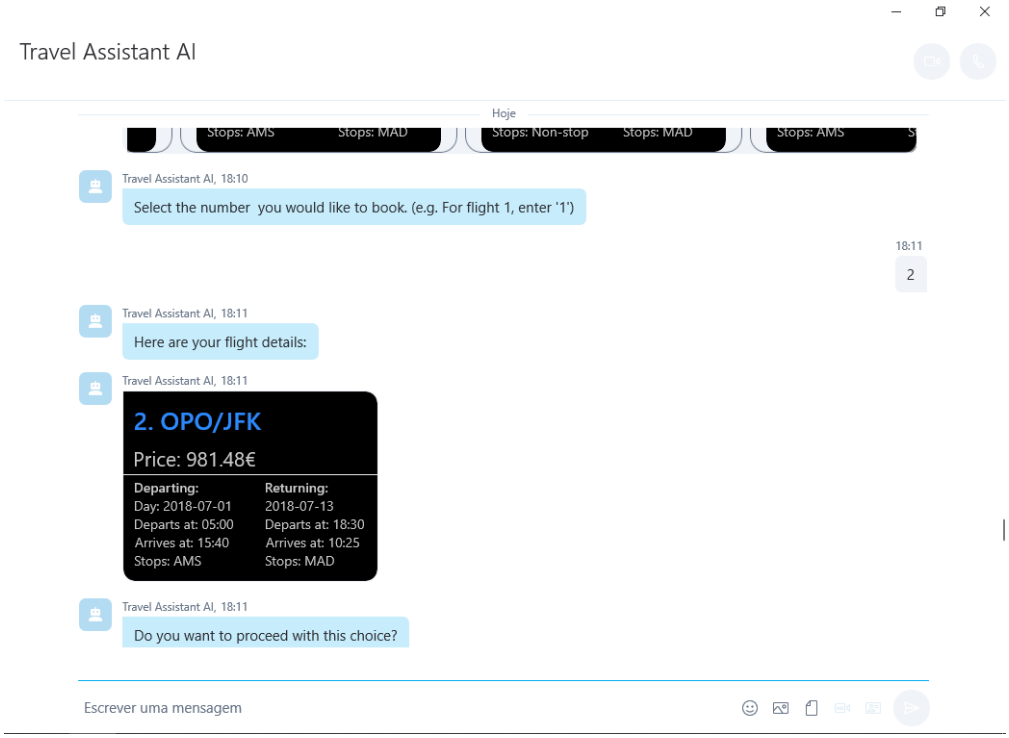
At last and to exemplify the developed product in its entirety, following there will be displayed a set of images, illustrating an actual example, of an entire booking process done through the chatbot, via skype.

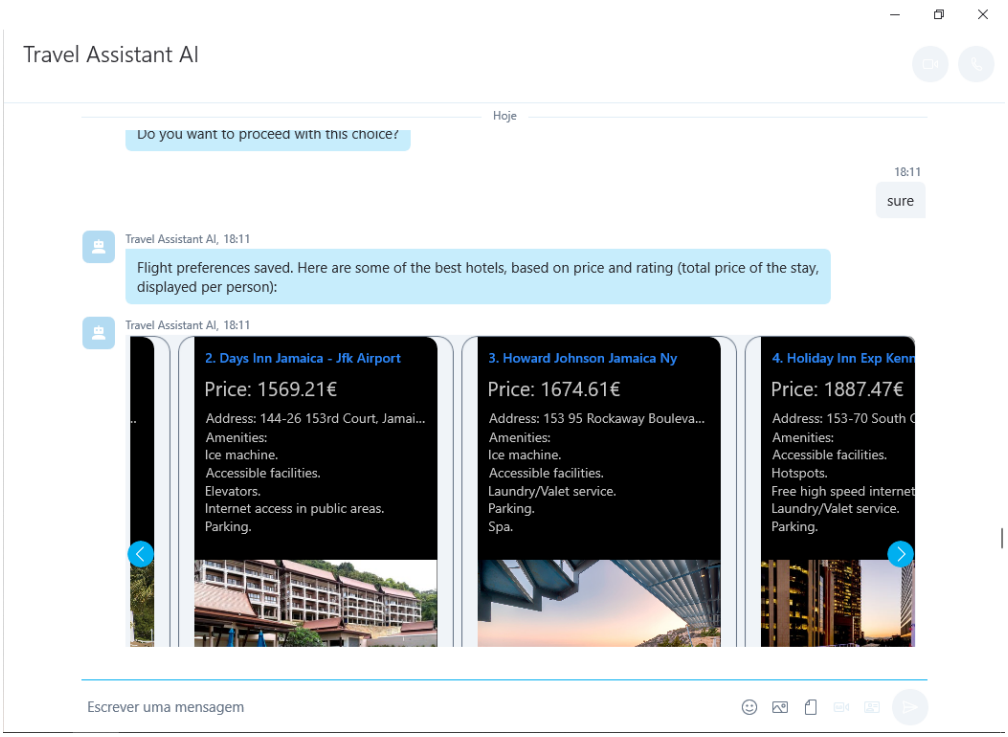
4.3.2 Travel booking example

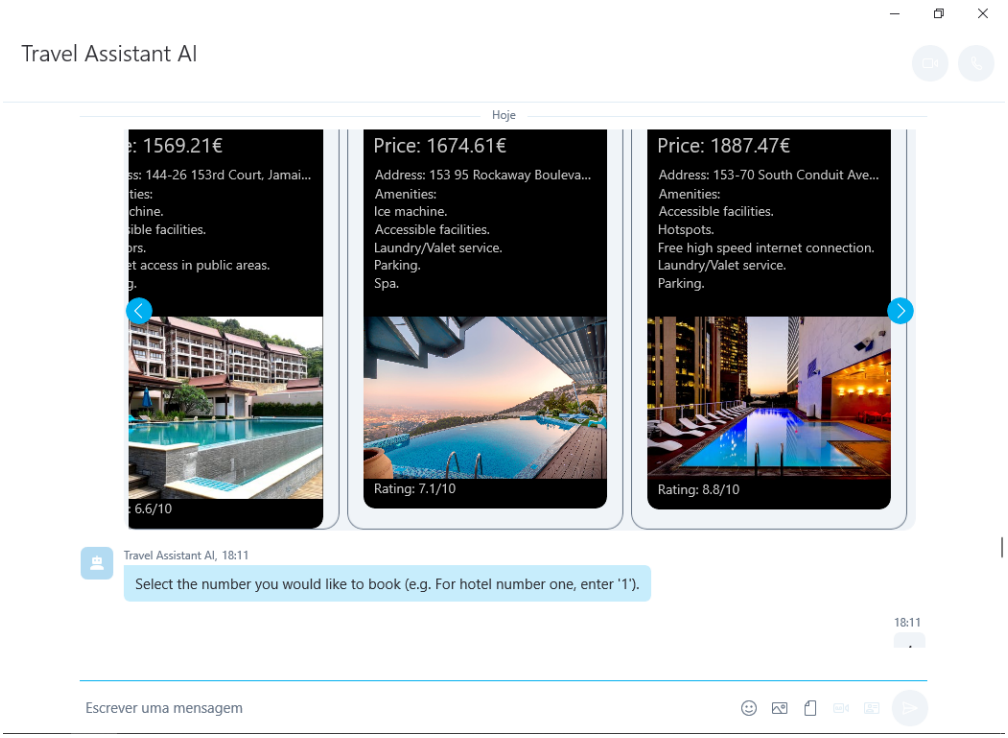
Figure 4.7: Booking simulation resorting to the chatbot

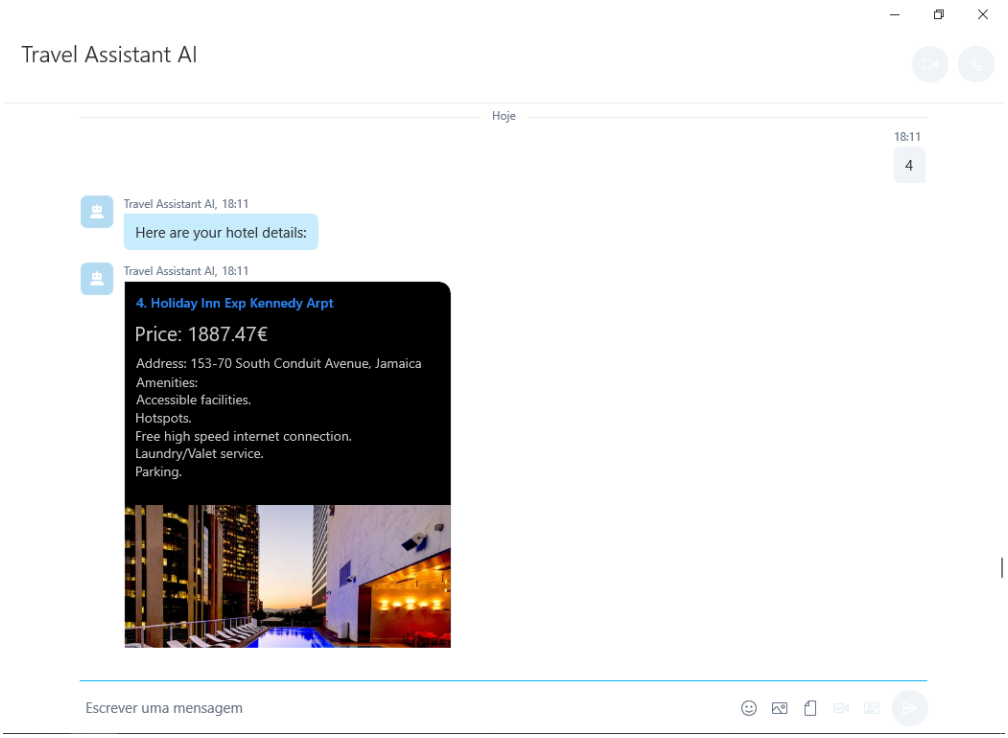


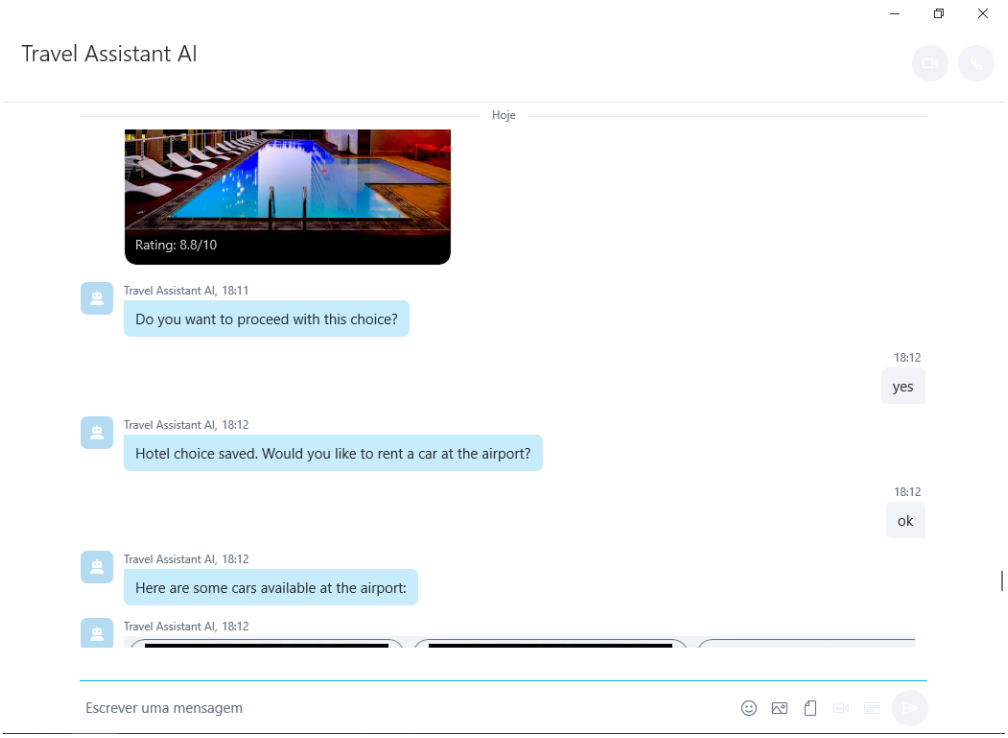

Travel Assistant AI
Hoje
july 13
Travel Assistant AI, 18:10
How many people is the trip for? (In case you want to travel alone, enter '1')
18:10
4
Travel Assistant AI, 18:10
Ok, now I will ask you to select your flight and accomodation details and in the end you can confirm everything and book it. Until then you can cancel the booking process anytime.
Here are some of the best flights found based on price and flight time (price displayed per person):
Travel Assistant AI, 18:10
2. OPO/JFK
Price: 981.48€
Departing:
Day: 2018-07-01
Departs at: 05:00
Arrives at: 15:40
Stops: AMS
Returning:
2018-07-13
Departs at: 18:30
Arrives at: 10:25
Stops: MAD
3. OPO/EWR
Price: 989.36€
Departing:
Day: 2018-07-01
Departs at: 12:35
Arrives at: 15:35
Stops: Non-stop
Returning:
2018-07-13
Departs at: 21:45
Arrives at: 09:45
Stops: MAD
4. OPO/JFK
Price: 1003.48€
Departing:
Day: 2018-07-01
Departs at: 05:00
Arrives at: 15:40
Stops: AMS
Escrever uma mensagem

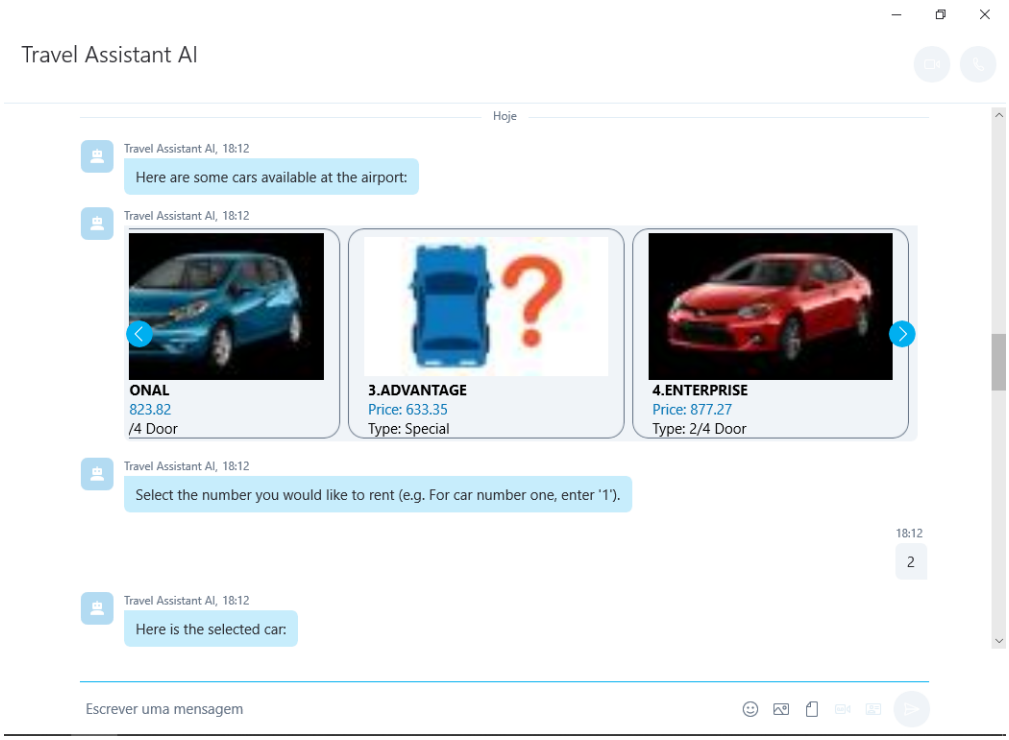

Travel Assistant AI
Hoje
Stops: AMS
Stops: MAD
Stops: Non-stop
Stops: MAD
Stops: AMS
Travel Assistant AI, 18:10
Select the number you would like to book. (e.g. For flight 1, enter '1')
18:11
2
Travel Assistant AI, 18:11
Here are your flight details:
Travel Assistant AI, 18:11
2. OPO/JFK
Price: 981.48€
Departing:
Day: 2018-07-01
Departs at: 05:00
Arrives at: 15:40
Stops: AMS
Returning:
2018-07-13
Departs at: 18:30
Arrives at: 10:25
Stops: MAD
Travel Assistant AI, 18:11
Do you want to proceed with this choice?
Escrever uma mensagem

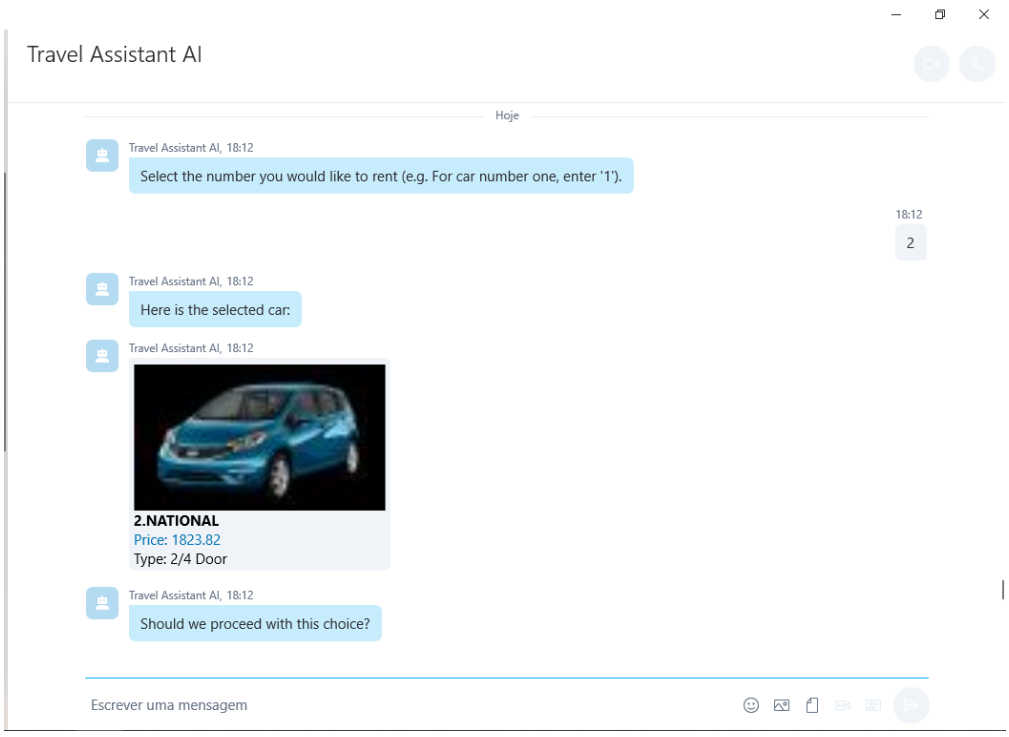

Travel Assistant AI
Hoje
Do you want to proceed with this choice?
18:11
sure
Travel Assistant AI, 18:11
Flight preferences saved. Here are some of the best hotels, based on price and rating (total price of the stay, displayed per person):
Travel Assistant AI, 18:11
2. Days Inn Jamaica - Jfk Airport
Price: 1569.21€
Address: 144-26 153rd Court, Jamai...
Amenities:
Ice machine.
Accessible facilities.
Elevators.
Internet access in public areas.
Parking.
3. Howard Johnson Jamaica Ny
Price: 1674.61€
Address: 153 95 Rockaway Bouleva...
Amenities:
Ice machine.
Accessible facilities.
Laundry/Valet service.
Parking.
Spa.
4. Holiday Inn Exp Kenn
Price: 1887.47€
Address: 153-70 South
Amenities:
Accessible facilities.
Hotspots.
Free high speed internet
Laundry/Valet service.
Parking.
Escrever uma mensagem

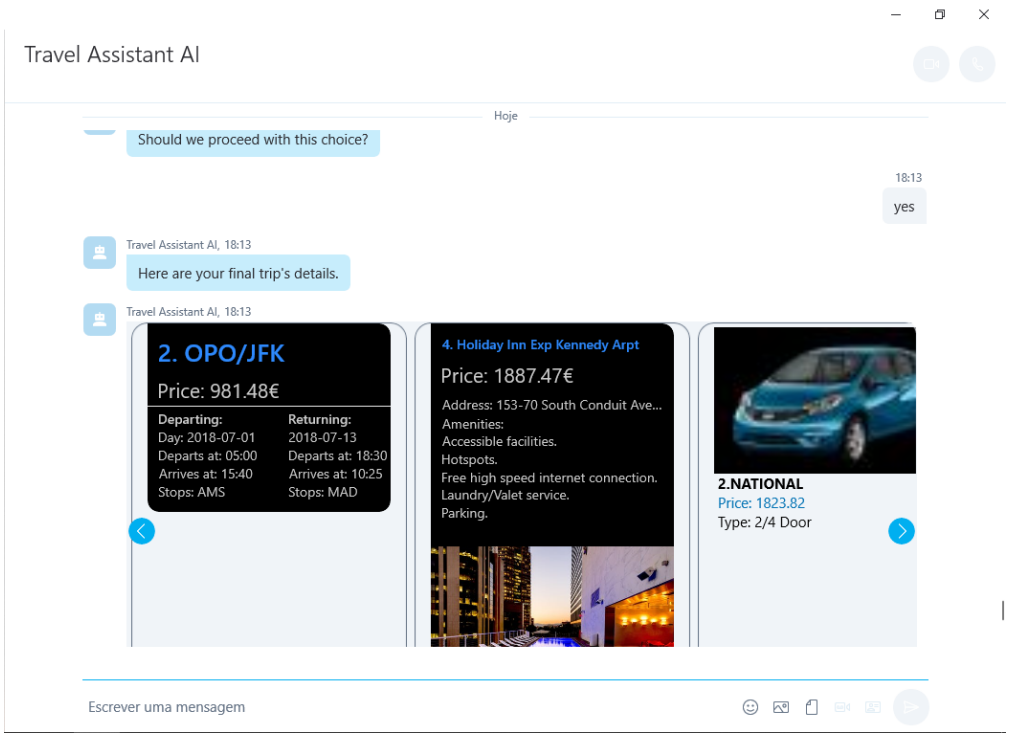

Travel Assistant AI
Hoje
Price: 1674.61€
Address: 153 95 Rockaway Bouleva...
Amenities:
Ice machine.
Accessible facilities.
Laundry/Valet service.
Parking.
Spa.
Rating: 7.1/10
Price: 1887.47€
Address: 153-70 South Conduit Ave...
Amenities:
Accessible facilities.
Hotspots.
Free high speed internet connection.
Laundry/Valet service.
Parking.
Rating: 8.8/10
Travel Assistant AI, 18:11
Select the number you would like to book (e.g. For hotel number one, enter '1').
18:11
Escrever uma mensagem

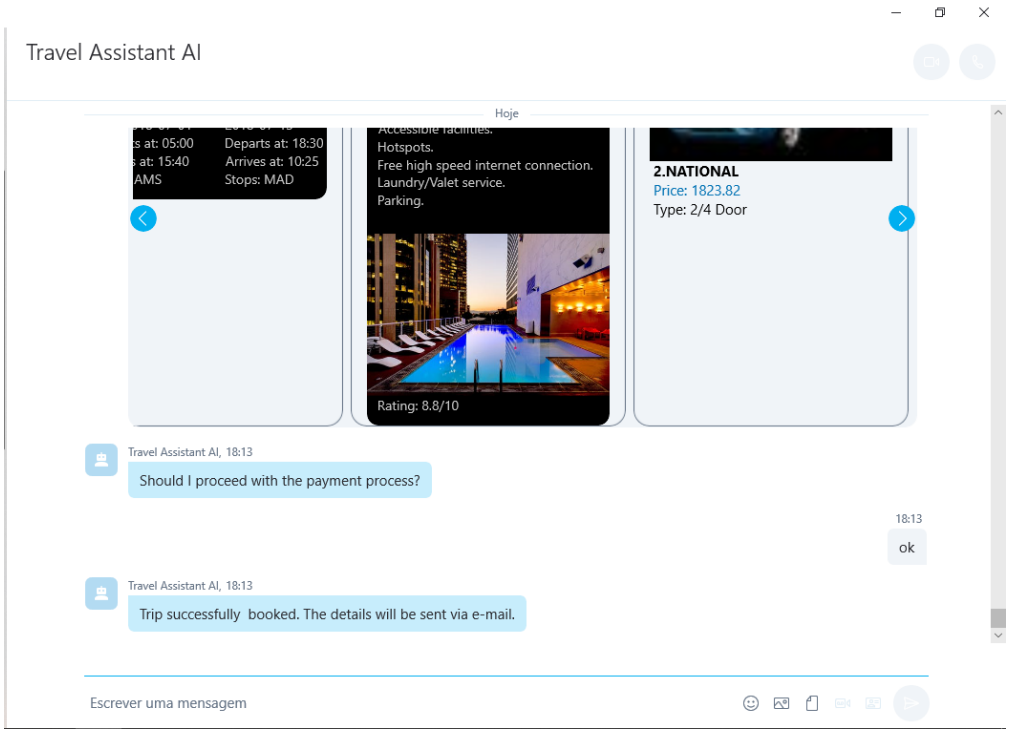

Travel Assistant AI
Hoje
18:11
4
Travel Assistant AI, 18:11
Here are your hotel details:
Travel Assistant AI, 18:11
4. Holiday Inn Exp Kennedy Arpt
Price: 1887.47€
Address: 153-70 South Conduit Avenue, Jamaica
Amenities:
Accessible facilities.
Hotspots.
Free high speed internet connection.
Laundry/Valet service.
Parking.
Escrever uma mensagem


Travel Assistant AI
Hoje
Rating: 8.8/10
Travel Assistant AI, 18:11
Do you want to proceed with this choice?
18:12
yes
Travel Assistant AI, 18:12
Hotel choice saved. Would you like to rent a car at the airport?
18:12
ok
Travel Assistant AI, 18:12
Here are some cars available at the airport:
Travel Assistant AI, 18:12
Escrever uma mensagem


Travel Assistant AI
Hoje
Travel Assistant AI, 18:12
Here are some cars available at the airport:
Travel Assistant AI, 18:12
ONAL
823.82
/4 Door
3.ADVANTAGE
Price: 633.35
Type: Special
4.ENTERPRISE
Price: 877.27
Type: 2/4 Door
Travel Assistant AI, 18:12
Select the number you would like to rent (e.g. For car number one, enter '1').
18:12
2
Travel Assistant AI, 18:12
Here is the selected car:
Escrever uma mensagem


Travel Assistant AI
Hoje
Travel Assistant AI, 18:12
Select the number you would like to rent (e.g. For car number one, enter '1').
18:12
2
Travel Assistant AI, 18:12
Here is the selected car:
Travel Assistant AI, 18:12
2.NATIONAL
Price: 1823.82
Type: 2/4 Door
Travel Assistant AI, 18:12
Should we proceed with this choice?
Escrever uma mensagem


Travel Assistant AI
Hoje
Should we proceed with this choice?
18:13
yes
Travel Assistant AI, 18:13
Here are your final trip's details.
Travel Assistant AI, 18:13
2. OPO/JFK
Price: 981.48€
Departing:
Day: 2018-07-01
Departs at: 05:00
Arrives at: 15:40
Stops: AMS
Returning:
2018-07-13
Departs at: 18:30
Arrives at: 10:25
Stops: MAD
4. Holiday Inn Exp Kennedy Arpt
Price: 1887.47€
Address: 153-70 South Conduit Ave...
Amenities:
Accessible facilities.
Hotspots.
Free high speed internet connection.
Laundry/Valet service.
Parking.
2.NATIONAL
Price: 1823.82
Type: 2/4 Door
Escrever uma mensagem


Travel Assistant AI
Hoje
Departs at: 18:30
Arrives at: 10:25
Stops: MAD
Hotspots.
Free high speed internet connection.
Laundry/Valet service.
Parking.
Rating: 8.8/10
2.NATIONAL
Price: 1823.82
Type: 2/4 Door
Travel Assistant AI, 18:13
Should I proceed with the payment process?
18:13
ok
Travel Assistant AI, 18:13
Trip successfully booked. The details will be sent via e-mail.
Escrever uma mensagem

As could be seen, the proposed product was successfully delivered, in a way of a virtual assistant, capable of handling a travel booking process, in a natural language speaking environment. As captured in the pictures above, it was possible to incorporate the booking of flight, hotel and car, through a simple and straight flow of conversation.
Effectively, the reviewed process can be separated into 5 parts. First, there is the one where the user asks for the beginning of the booking, followed by inputting its details. Immediately after, come three similar parts, each where the user is given a choice among a group of four cards, which describe the products in question, representing flights, hotels and cars, respectively, from where the user selects one in each phase, by typing the number of its card and after selecting, is asked to confirm it, to make sure there was not any mistake.
In fact, it could be verified that the product didn't need any complex textual interaction from the user, having the entire process built to respond to short answers, like yes or no questions, or choices made by numbers, in order to make it faster and easier to use, so that, anyone could manage it without major difficulties.

Chapter 5

System analysis and results validation

As the prototype became fully operational, it was possible to start testing it, in order to obtain eventual conclusions about the initial proposed goals. In this chapter, it will be described how the prototype was tested, analyzing the obtained results, resorting to statistical metrics, looking to identify certain patterns related to its utilization.

5.1 Experimental Design

In order to get a more accurate evaluation of the designed prototype, it was decided to have it tested by multiple potential users, who would then express their opinion about it, by filling a survey.
More specifically, the test process consisted in having people making a reservation, not only in the chatbot, but also in a regular, well established web platform, so that, a comparison between the two experiences could be made. The chosen web platform was Expedia [26], due to its similar structure to the chatbot's, due to their similar straight flows of processing, regarding the booking of a flight, hotel and car. The way the tests were conducted, was by having a user randomly starting by booking a trip in either one of the two platforms, the developed prototype and Expedia, followed by answering to a group of selected questions about the use of the tested platform, immediately after its test and then, doing the exact same process with the other platform. As the testing proceedings were happening, the time each execution took to complete was recorded, in order to have an additional statistical measure.

5.1.1 Survey structure

As for the surveys, they were conducted in Google forms [27] and consisted of four different parts, an introductory one, where each person filled with personal and travelling experience information, followed by the two similar parts, regarding both chatbot and expedia use, respectively and at last, it was finished with an open, optional question, regarding the experience of using a chatbot.
Among the personal data collected was the person's age, literacy degree, travel frequency and usual travel booking method. All these variables were collected to try and find statistical patterns,

Nº	Question
1.	I think that I would like to use this system frequently.
2.	I found the system unnecessarily complex.
3.	I thought the system was easy to use.
4.	I think that I would need the support of a technical person to be able to use this system.
5.	I found the various functions in this system were well integrated
6.	I thought there was too much inconsistency in this system.
7.	I would imagine that most people would learn to use this system very quickly.
8.	I found the system very cumbersome to use.
9.	I felt very confident using the system.
10.	I needed to learn a lot of things before I could get going with this system.

Table 5.1: Table of SUS questions

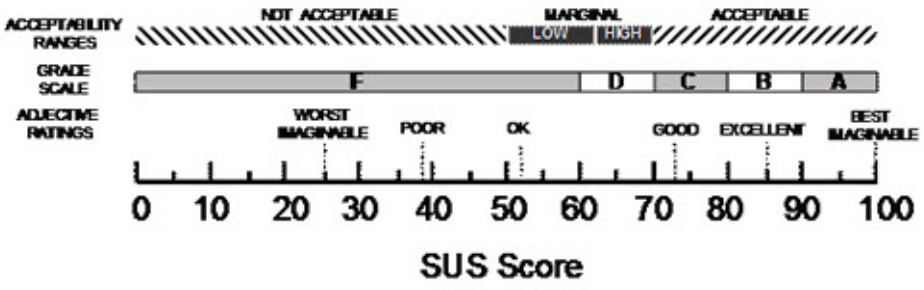


Figure 5.1: SUS classification scale.[3]

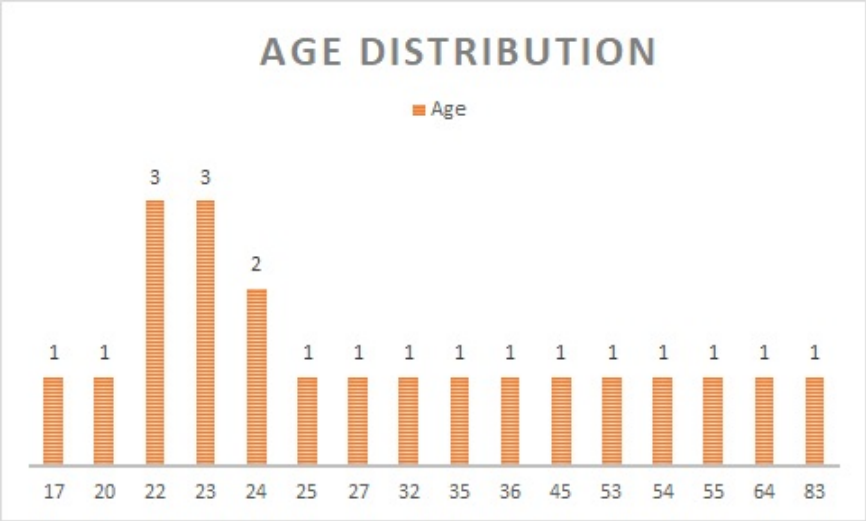


Figure 5.2: Age distribution of the respondents

among certain groups of people.

In regards of testing each platform's usage experience, System Usability Scale [28] questionnaire templates were used, a group of standardized tests made to evaluate the usability of a certain system. These consist in a group of ten total questions, about the experience of using a system, which can be consulted in table 5.1, being that, some questions are similar to each other, to guarantee the user answers the survey consciously.

Once the answers to the SUS were obtained, the process of scoring the test followed. Being that, every answer to the questions goes through a range of 1-5, being that 1 represents the answer *strongly disagree* and 5 represents *strongly agree*. To obtain the final score for each test, the following formula was used $((q1-1)+(5-q2)+(q3-1)+(5-q4)+(q5-1)+(5-q6)+(q7-1)+(5-q8)+(q9-1)+(5-q10))\times 2,5$, where q_i represents the score in each one of the 10 individual questions. The final score will be inside a range of 0-100 and its value can be interpreted resorting to the scale from figure 5.1 retrieved from from the article [3], which explains in detail the entire classification process.

To conclude the survey, there is a last section with an optional question regarding the chatbot utilization. It was meant to gather some personal opinions, to complete the statistical data obtained in the SUS.

5.2 Results

The testing process previously described, was performed by a total of 25 different people. For a better interpretation of their responses, some personal information and traveling habits about them were also collected.

More specifically, there is in figure 5.2 a graph containing the respondents' age range distribution. In fact, the average age of those who took the tests was 33,6 and taking a look at the graph,

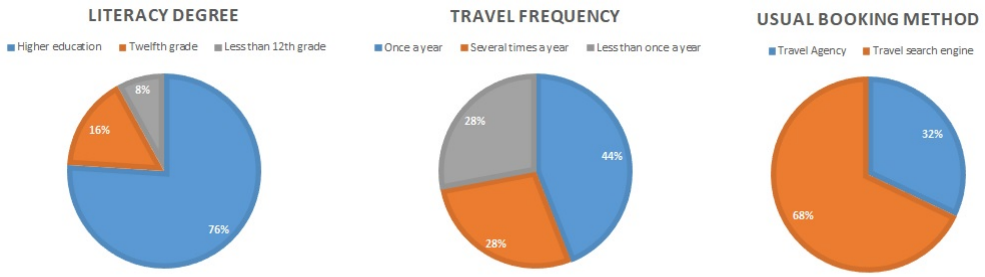


Figure 5.3: Respondents additional information

one observes a larger abundance in the twenties sector, which could mean that the majority of those who attended the tests, already grew used to relying on computers. Ideally, a more singular distribution of ages would bring more benefits to the analytic process, since it could, more likely, better highlight age related patterns. On the other hand, a more abundant presence of older users, would also contribute to improve this study, regarding the benefits that the chatbot could bring to those less capable and not so accustomed to work with technologies.

Additionally, in figure 5.3 are represented three diagrams which contain more details about those who took the survey, including their study degrees, travel frequency and regular travel booking methods. The biggest take away here is that the majority of the respondents are highly qualified people, who are used to work regularly with online booking search engines.

In fact, the literacy degree chart, comes to support the analysis made towards 5.2, being that, having a high number of well qualified respondents, the usability scores were projected to be high from start, which translates into a lack of less qualified people to test the product, to gather whether or not, its simplicity could in fact, be a real advantage over the most sophisticated traditional booking platforms' layouts.

As for the travel frequency results, one concludes that, the large majority of those who took the tests, travels at least once a year, highlighting the big demand there is in nowadays booking market, which encourages the development of new tools for the industry. In this particular case, with such percentage of yearly travelers, it translates that, even if most of them are not inclined to start using chatbots as a reference for trip booking, still, there is a chance that a significant slice of the market could see it as a useful tool. At last, the dominant percentage of people who book their trips online represents a good possibility of future chatbot clients, since it would be a small step to replace a search engine, for an also online booking experience, as is the chatbot. Although, keeping in mind that a possible transition to chatbot usage, would have to be slowly integrated, due simply to the fact, that psychologically, people tend to stay in their comfort zones, instead of trying to learn new habits, or how to work with new tools.

The score of each question contributed for the final score of every SUS done. In table 5.3 are displayed the average scores from the 25 total participants, for the two platforms. Additionally, in the same table can be consulted the average times the respondents took to go through the booking process in each service. It should be noted that expedia's booking process didn't contain the

Nº	Chatbot	Expedia
1.	3,52	3,8
2.	1,68	2,24
3.	4,4	3,64
4.	1,96	1,88
5.	4,08	3,8
6.	1,84	2,12
7.	4,08	3,48
8.	1,36	2,08
9.	3,56	3,92
10.	1,36	1,64

Table 5.2: SUS average scores for each question. (1-strongly disagree; 5-strongly agree)

confirmation step that was implemented in the developed prototype, being that, for every confirmation of any selection, a user wasted in average 13,88 seconds, which translated into a total of 55,52 seconds for each test, due to the four times the users had to confirm flight, hotel, car and total trip, respectively. That being said, for a more accurate comparison, the chatbot's average time, represented in the table, corresponds to the average of the collected times, already subtracted by 55,52.

5.3 Analysis

In this section, the previously obtained results will be analyzed and the outcome that they could possibly represent, going through all the aspects represented in the analytic data.
Starting by taking a look at 5.2, one notices that the surveys translated into an advantage for the chatbot in both time and SUS score.
For what time is concerned, it was expected from start, to obtain smaller times from the chatbot tests than from web ones. In fact, one of the main characteristics of the virtual agent, is its simple layout, meant to be easily understandable and intuitive, hiding some unnecessary information

	Chatbot	Expedia
Time	2 min 11 sec	2 min 32 sec
SUS score	78,6	71,7

Table 5.3: Table containing the averages for time token to complete the tests and SUS scores.

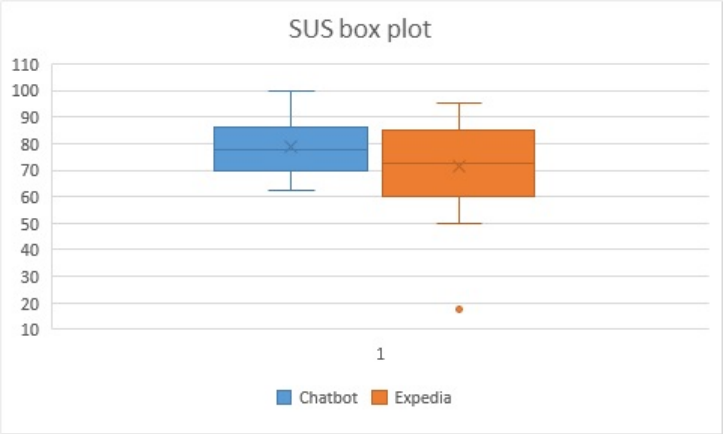


Figure 5.4: SUS scores distribution comparison

displayed in the traditional platforms, that would take the user extra time to read, in order to fully understand the process happening. In this area, the twenty-one seconds difference between the two average measures, validated the premise that the inclusion of the chatbot in the travel industry would translate into faster booking systems.

As for the SUS results, the chatbot noted a slight advantage over the web platform, with both scores labeling their systems as very good, according to 5.1. Further analysis into the SUS questions will be done in the following paragraphs, but in a first approach to the overall results, one might wonder that, perhaps, although the current available systems satisfy their users, they would be open to the idea of trying the chatbot approach, in a way of looking for an improvement to their booking experiences.

5.3.1 Usability comparison

This section is dedicated to highlighting the differences, between the usability results from both platforms. Starting by taking a look at graph 5.4, it's visible that the chatbot obtained much more consistent results, with an average distribution between 70 and 90, while the distribution regarding expedia was wider, having its average going as low as nearly 60. Not only do these results indicate that the chatbot got better average usability classifications, but also that, since its range of results was tighter, people had a more consistent opinion that this platform was solid and easily usable. Although both systems' overall SUS scores were pretty close, there were areas inside the tests, where its results noted a more accentuated variation from one system to another and were worthy of being separately investigated. In order to make a deeper analysis into the SUS scores, table 5.4 was constructed, where the difference between each question's score for the two platforms is highlighted. More precisely, the table refers to the absolute difference between each answer's average score, either in total score difference and percentage difference, being that, the percentage is calculated by dividing the score difference for the maximum difference possible, that would be of 4, since the answers vary from 1 to 5. Furthermore, since in some of the SUS questions,

Nº	Total	Percentage	Advantage
1.	0,28	7 %	web
2.	0,56	14%	bot
3.	0,76	19%	bot
4.	0,08	2%	web
5.	0,28	7%	bot
6.	0,28	7%	bot
7.	0,6	15%	bot
8.	0,72	18%	bot
9.	0,36	9%	web
10.	0,28	7%	bot

Table 5.4: Absolute difference in score average, between chatbot's and expedia's SUS questions

getting a lower grade is considered a good evaluation for the system, because they are written in the negative form, more explicitly, the even questions(2, 4, 6, 8, 10), to clarify their classifications, in the third column of the table, there is an indication of which platform performed better in that particular question, namely, having a lower grade in the negative questions, or a higher grade in the affirmative ones.

According to the results, with regards to the SUS scores, the table's third column confirmed the overall superiority observed in 5.2, giving an advantage ate scoring level to the chatbot, in seven out of the ten questions. Furthermore, the higher gap in scores difference was obtained in the items 2, 3, 7 and 8. When confronting those numbers with table 5.1, one concludes that, in general, all the four questions in which the chatbot displayed significantly better ratings than the web platform, were related with the system's complexity and with the degree of difficulty in using it, having this way, the data supporting the premise that the use of the chatbot, could generally simplify the entire booking process,for a person that opts to go with it.

On the other hand, approaching the item that translated in the best approval rating, towards the web service's side, there is, in question number 9, a significant gap regarding safety in using both systems. Actually, these results might be explained with the lack of choosing options displayed by the chatbot prototype, comparatively to the more elaborate and customizable expedia platform. Although this solution might accelerate the entire booking process, some people would probably prefer to take their time, in analyzing carefully every hotel or flight option they would have available, instead of just picking one from a small group of options previously selected by the chatbot, as it was in this prototype's case, with the customers only having four distinct options to choose from, in each selection phase. In fact, the only way of changing people's opinion towards chatbot booking safety would be to guarantee them that the small group of options the chatbot presents

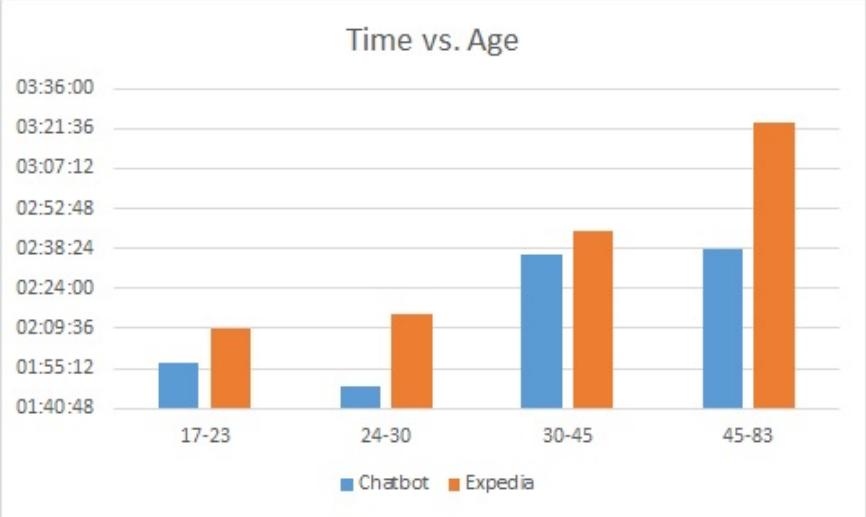


Figure 5.5: Age influence over recorded times

them, were the absolute best available. With that in mind, even though great booking choice algorithms might come up in the near future, it will always be hard to predict what each individual person, or groups of people would look for in each destination. Alternatively, a perhaps easier way of combating the safety problem, would be to introduce a dynamic search change system, that would act in a way that, the user could ask the agent to search for other options based on a specific idea.(e.g. "-Show me hotels near the football stadium, please)". Continuing to analyze the web service's advantages, there is in question number 1, its second biggest differential gap towards the chatbot, in an item that evaluates the possibility of future use of the system. In fact, consulting table 5.3, it is verified that, although the respondents' average score regarding the possibility of using a chatbot in future experiences is positive, still the probability of resorting to the traditional methods is slightly bigger. This could be explained by the fact that, people in general, tend to feel safer in their comfort zones and when challenged to change a habit that they are accustomed to, for an entire different one, might show some resistance, that is, they could feel that replacing a reliable process with a new intriguing one, would be a risk that they'd might not be willing to take. Yet, since the difference is not that big between the two platforms, it could indicate that in time, people would slowly change their opinions if they see advances in this sector.
At last, from the remaining questions, there is not much information to retrieve, as the chatbot noted a small advantage in scores, but essentially, they ranked both systems as consistent and well integrated.

5.3.2 Age influence analysis

In order to better understand whether or not, the age difference actually played a factor in rating both platforms, the gathered results were grouped by age intervals, to search for response patterns among the same peers. Being the age distribution as displayed in 5.2, they were then separated into four different groups, being that, in each one of those groups, will be analyzed the gap between

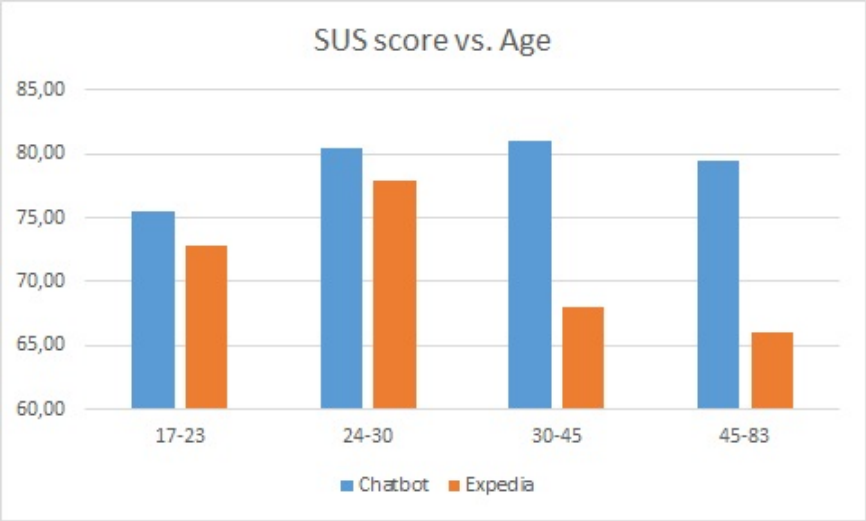


Figure 5.6: Age influence over SUS scores

the results obtained in the two tests, either for time and SUS score.
Starting with the temporal analysis, there is in figure 5.5 a plot representing the average time, each age range took to execute a reservation, both on the prototype chatbot and on the expedia platform. In general, the chatbot was always faster than the web platform and, with the exception of the chatbot's time in the 24-30 range, there was a pattern of increasing times on either platform, as one progressed in age groups, what comes to support that, younger people are more accustomed to book online travels than their older peers. Additionally, a huge part of this analysis consists in the interpretation of the gap between times recorded in the two platforms. As the results show in the graph, the gap in time intervals is not significant in any age group, apart from the last one, where was recorded a record gap of 43 seconds. These results indicated that, in fact, the chatbot could really be successfully applied, to help older people, less familiarized with the use of internet technologies, booking their trips in a simpler and easier way.
Similarly, in figure 5.6 can be found a graph comparing the scores given by the users in both usability tests. Again, the results noted a constant superiority towards the chatbot rating. As previously discussed around figure 5.4, the chatbot's scores were much more consistent than the expedia's ones and when analyzing them separately by age groups, was seen that they didn't differ much from each other, contrary to expedia's, that were significantly lower among older respondents. In the same way that the previous graph was interpreted, the larger difference in results obtained from older age groups, comes to match the longer time differences obtained between the two platforms among the same older people, which, again, suggests that older people found it easier to work with the chatbot, than they did regarding the traditional booking methods.

5.3.3 User feedback summary

The last part of the survey contained an optional open question, where the respondents were challenged to write a statement describing their general opinion about the experience of having used

the chatbot to book a trip and what they thought that could be the future of chatbots in the travel booking business. Following, are be highlighted some of the most notable points made by the users, being that the full responses are available in the annex section A(in its original version, in Portuguese).

- The chatbot looks like an interesting concept, but still feels more comfortable using regular websites.
- The chatbot seems simpler to use.
- As someone with good IT skills, I feel more limited using a chatbot.
- The lack of control is a con, but it feels like a good investment to create new algorithms that would make it better and make the existing platforms much easier to use.
- A lot of people would benefit in using a chatbot because it feels like a much more personal experience.
- It offers less flexibility when you need complex choices, but seems like a very appropriate option for those not familiarized with ITs.
- Interesting solution, since its clean menus make it easier to visualize options, avoiding the usual unnecessary extensive lists.
- It probably will overtake web platforms in the future, because it's much more intuitive and practical.
- It seemed simpler, felt safer and was less complicated to use.
- It lacks a searching criteria, as I would like to look for different hotels and cars, than those that were presented
- Its limited options are a downside that need some improvement.
- Equivalent to the existing alternatives but simpler and more objective.
- Good option for older people.

As it could be seen, there were some different opinions around the subject, some of those which validated results already presented in this chapter. In general, the respondents felt like this idea was very interesting and if well developed, had the potential to make a significant impact, in the future travel booking market.

5.3.4 Analysis review

Generally, the results obtained throughout the testing process, were very satisfying, since they allowed to identify some tendencies and patterns among the different users. In fact, some of them even helped to clarify some of the questions proposed in the goals set, at the beginning of this study.

Despite that, it would be even more interesting to have the opportunity of testing a more diverse set of people, since the majority of the respondents who took the tests, had a superior education and were very familiar with informative technologies.

Chapter 6

Conclusions and future work

6.1 Conclusions

To conclude this dissertation, an overall balance of the project will be made, in a way of clarifying the important aspects to highlight, regarding chatbots and their future within the travel industry.
To clarify some ideas, regarding chatbot usage within the travel industry, some research about both fields was made, approaching subjects that could have a potential impact over the development of a chatbot prototype.
After carefully designing and projecting the model, the prototype chatbot was successfully built, ending in an automated conversation system able to guide a natural language speaking user, through a travel booking process. More specifically, the built project's function, is to receive travel details, such as destiny, length of the stay, and number of passengers, to search for travel options regarding those preferences, being those options about, flights, hotels and cars, respectively in this order, handling the entire process, in a straight flow of chat room conversation.
Prior to the project's development, some pros and cons, regarding its utility, were formulated, in a way of questioning whether or not, it would be worth it, to further invest in the studying and improvement of this technology, so that they could be questioned and validated during this dissertation. To help prove this point, the prototype was then tested by a number of respondents, who followed it by answering to a survey containing not only specific questions regarding its usability, but also a section where the users inputted some personal details and travel habits, so that, specific patterns could be looked for, among the statistical data.
The main conclusions extracted out of the results from the tests and surveys, done with the users and from personal experience researching, building and testing the system are now presented:

- The chatbot provided a faster booking experience. As the recorded times in the testing process evidenced, there was a significant difference in the time token to book a trip in the chatbot than in a traditional web platform. While this might not be an important aspect for people who travel once or less per year, those who travel in business, with high frequency and are used to book trips regularly, would definitely prefer to resort to a tool that would save them some precious time.

- Intuitive layout, appropriate to less capable users. Perhaps the biggest takeaway, from the conducted study, was that the chatbot provided a much simpler interface, hiding unnecessary information usually displayed in web engines, which makes things much more clear, for people who are are not accustomed to book online trips, having the tests translating the most favorable chatbots results, among older generations.

- Lack of control. The small amount of options the chatbot presents, might take people to wonder if the displayed options, are in fact, the best available options in the market. This lack of liberty in choice, was highlighted by some users that found the traditional services safer, in terms of giving a better sense of what the market has to offer.

- Potential for a slow transition towards chatbot use. The surveys indicated that most people nowadays, travel at least once a year and research backed up that growth, predicting that the number of travels per year will even raise in the near future and more trips being booked, means more potential chatbot clients. Combining that with the high percentage of users who already book their trips online, retrieved from the surveys, and the high number of people, who stated that would view themselves using a chabot in the future, everything indicates that it would be a smooth transition, for those users, to move from the traditional websites to a chatbot booking approach.

- Difficulties in gathering the best travel options for each individual. Even though, techniques such as recommender systems and user profiling are going through major upgrades, it will always be difficult to gather a small group of options, that would satisfy each client the most, since it would take to gathering preferences from every user, about every possible destination.

- Better overall usability results. The main aspect retrieved from the tests was that, in general, the users' responses graded the chatbot system higher than the online travel booking platform , which gives a big incentive to keep on investing in this area, since the majority of the respondents consistently classified the chatbot as a very well usable system.

To summarize, the general feedback from the tested users was very positive, recording faster times and obtaining better overall classifications in the chatbot, than the traditional online booking methods. It surely, still has a long way to go, but as far as this dissertation work is concerned, results suggest that chatbots may be a valid alternative to traditional booking methods, being that, combining the travel booking area, with the artificial intelligence technology looks to be very promising.

6.2 Future work

The major concern towards the use of a chatbot to book online trips is the fact that, it gives the users a small range of choices. That being said, for it to be effective, the search algorithm behind

those choices must be as effective as possible, in order to assure the customers, that the bot will not only provide them a faster and more intuitive experience, but also that they will be presented with the best options in the market. If in fact, a system can be developed that guarantees an easier and more productive experience to the customers, then one could speculate that the chatbot could be a success among travelers and compete with the traditional booking methods.

One possible way of supporting the development of these algorithms, would be to ask the customers to create personal profiles, where they would provide personal information regarding their trip preferences, such as top lists of preferable flight or hotel companies, trip budgets, preferable flight schedules, etc. This information would play a crucial part for the agent to provide more accurate options, that would not need to be in big quantity to satisfy the customer.

In the same way, an effective step to upgrade the developed prototype, would be to implement changes in the displayed options according to certain criteria. For example, if the user didn't like the options the chatbot found, it would ask it to search for different ones such as, less expensive hotels, flights at an earlier time or more luxurious cars. Although this option would take a considerable amount of time, it would be easily integrated in the current prototype and would make it a much more complete product. Also, a great and unique use of the chatbot, would be to fully adapt it to interact with the user via audio. This measure would, not only please a large quantity of the regular users, but would also have a huge impact among visually impaired people, since it would allow them to interact with the agent, without having to read or write. Furthermore, it would be possible to incorporate this feature in the current project without making major changes, since voice recognition is a technology already developed and present in general virtual assistants, like Siri [29] or Google Assistant[30], which means that, developing the project to interact with Google Assistant instead of Skype, would make this feature possible. Actually, adding this voice component, expands its potential, allowing to incorporate some other features, providing the users a much more complete experience, in a way that, it would not only help them booking trips, but could also talk about a lot of different subjects and give assistance in a large variety of ways.

Appendix A

Appendix

Here are displayed in its original language the overall responses from the surveys. Note: The age distribution is incomplete, since the surveys were updated and in Google forms only appeared the exact age of some users, but the correct distribution was already uploaded in a graph in chapter 5. After the surveys' results, there is also a table A.1, containing the exact time each user took to complete each test. It should be noted that those times, represent the original recorded times and don't include the subtractions considered in the averages calculated in 5.

A.1 Surveys

Inquérito sobre o Chatbot para reserva de viagens

QUESTIONS RESPONSES 25

25 responses

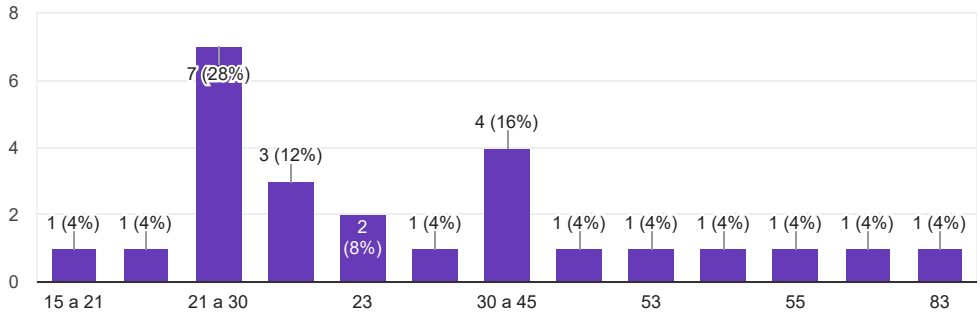
SUMMARY INDIVIDUAL

Accepting responses

Introdução - Recolha de dados pessoais

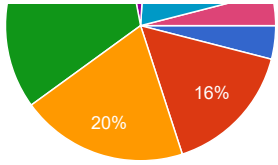
Idade

25 responses



Habilitações

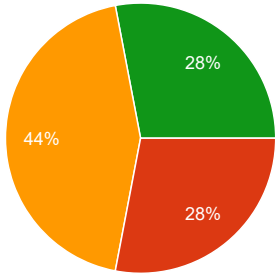
25 responses



Doutorado
Licensiado
Estudante

Viaja com frequência?

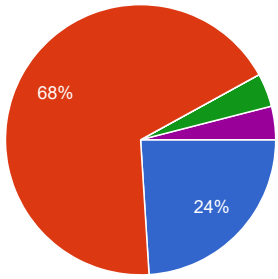
25 responses



Não costumo viajar
Esporadicamente
Uma vez por ano
Várias vezes por ano

Qual o seu meio habitual para fazer reservas de viagens?

25 responses

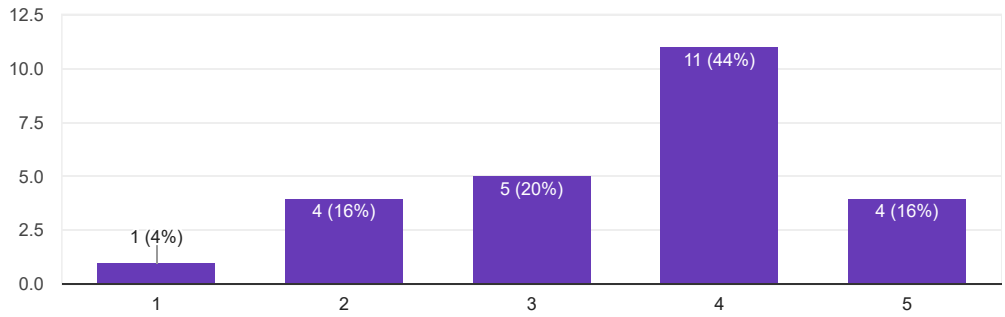


Ir a uma agência de viagens
Recorrer a motores de busca de viagens (Skyscanner, Booking , etc.)
Recorrer a sites particulares de Companhias aéreas/ Hoteis específicos (Ryanair, Hotel ibis , etc...)
outra pessoa
por vezes atraves de agencia de viagens.

Parte 1 - Estudo sobre reserva de viagens recorrendo a um Chatbot

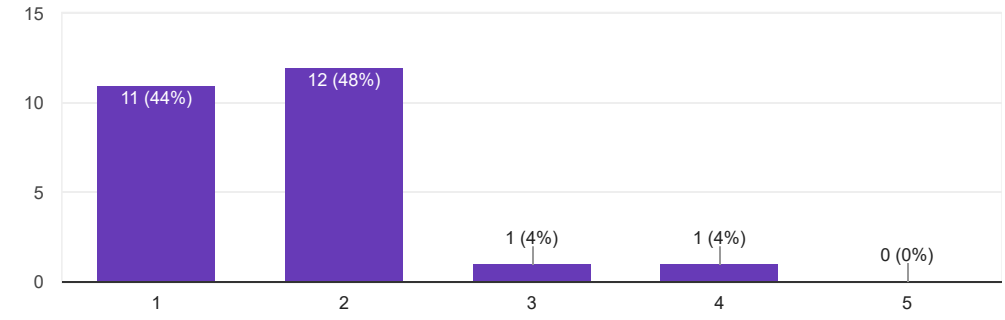
1. Penso que gostaria de utitlizar um chatbot com frequência para futuras reservas de viagens.

25 responses



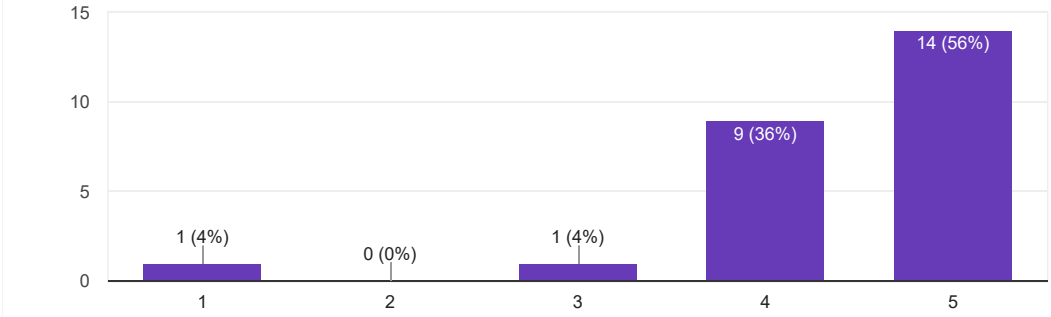
2. Parece-me demasiado complexo usar um chatbot, para reservar viagens.

25 responses



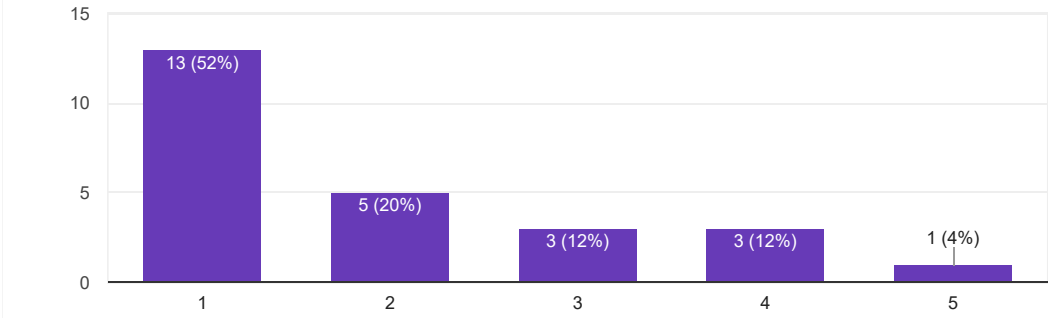
3. O sistema pareceu-me fácil de utilizar.

25 responses



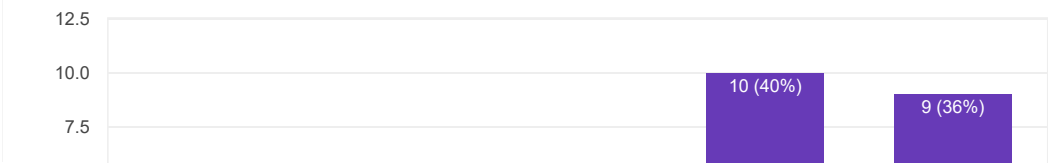
4. Penso que necessitaria de apoio técnico, para marcar uma viagem utilizando um chatbot.

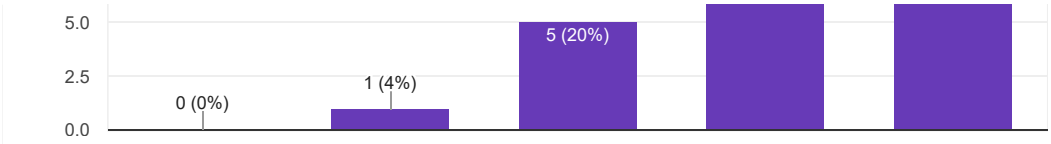
25 responses



5. Achei as várias funções deste sistema, bem integradas entre si.

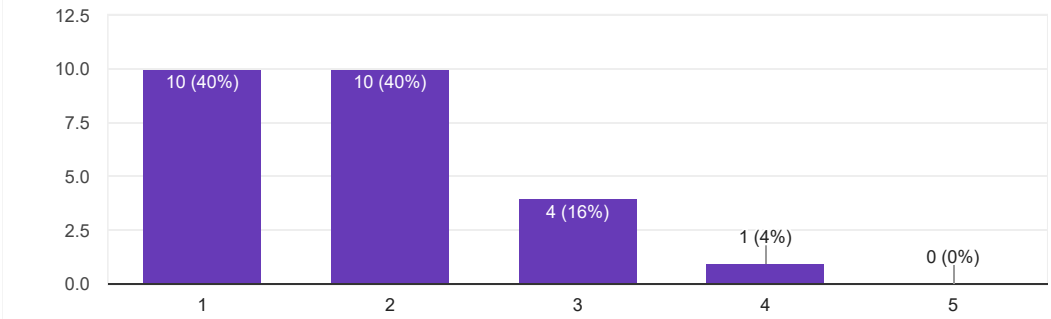
25 responses





6. O sistema pareceu-me bastante inconsistente.

25 responses

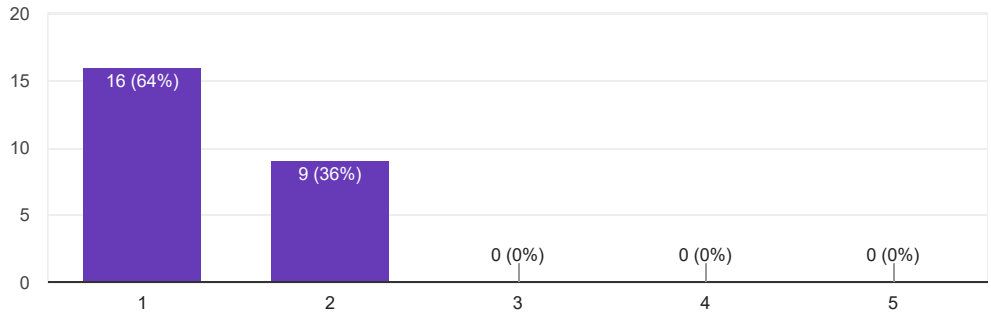


7. Penso que a maioria das pessoas, conseguiria facilmente reservar uma viagem utilizando um chatbot.

25 responses

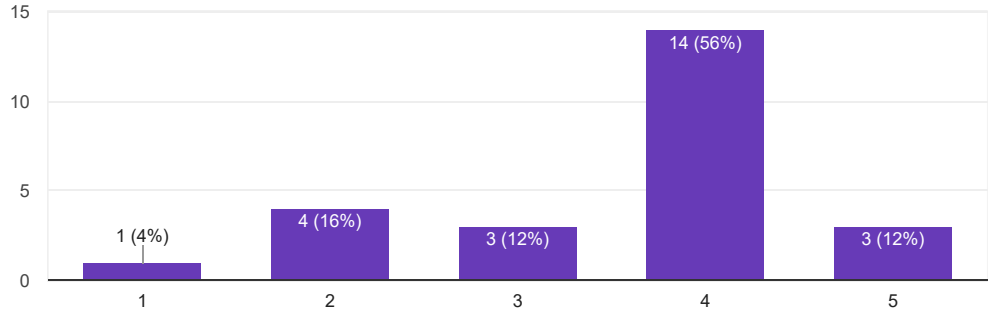
8. Achei o sistema bastante complicado de utilizar.

25 responses



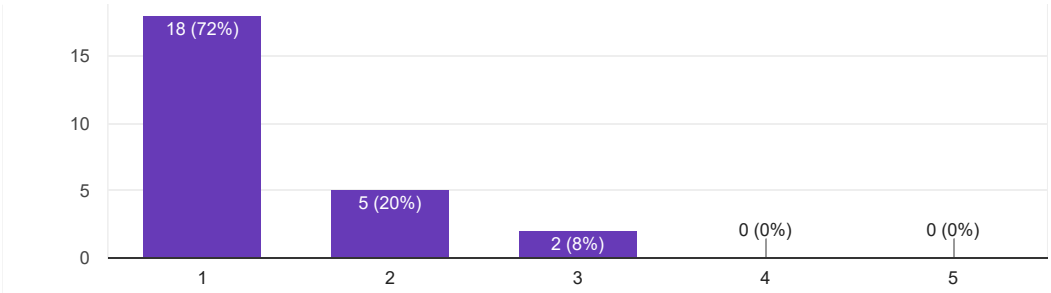
9. Sinto-me seguro e confiante a utilizar um chatbot para reservar as minhas viagens.

25 responses



10. Precisei de aprender coisas novas para saber utilizar este sistema.

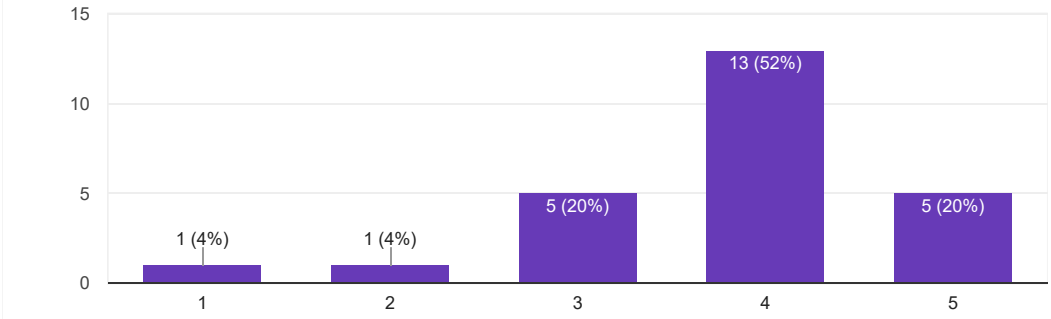
25 responses



Parte 2 - Estudo sobre reserva de viagens recorrendo a plataforma web

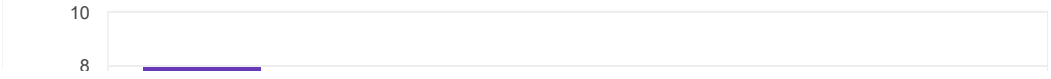
1. Penso que gostaria de utitlizar uma plataforma web com frequência para futuras reservas de viagens.

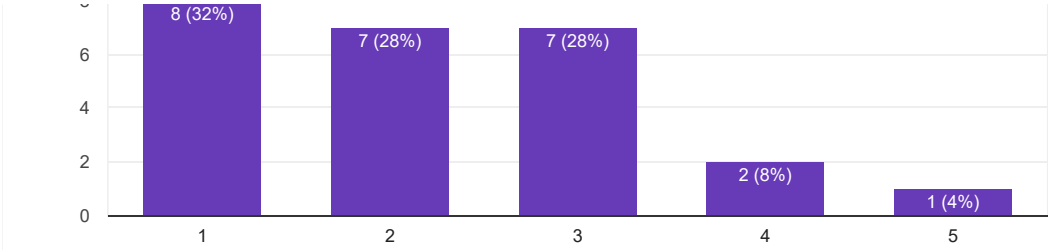
25 responses



2. Parece-me demasiado complexo usar uma plataforma web, para reservar viagens.

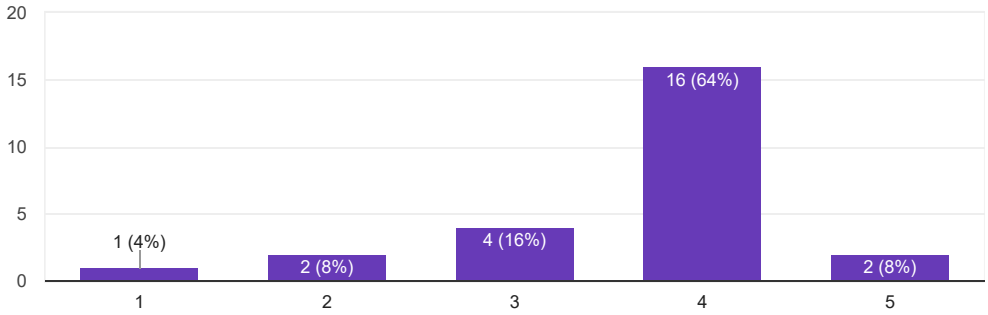
25 responses





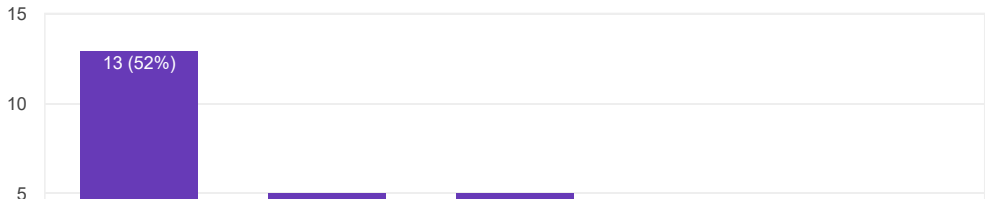
3. A plataforma web pareceu-me fácil de utilizar.

25 responses



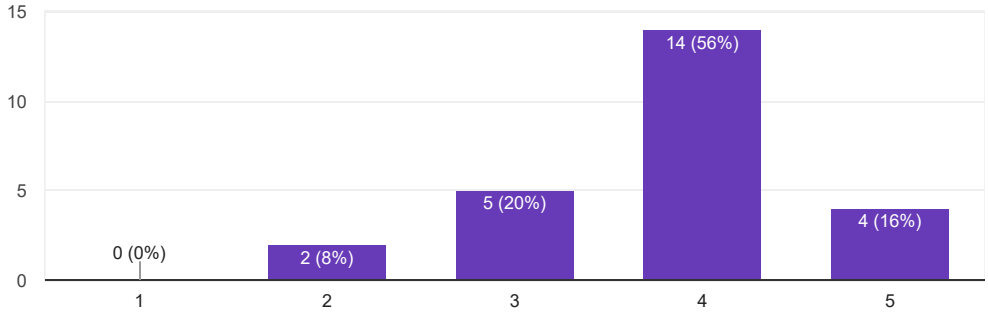
4. Penso que necessitaria de apoio técnico, para marcar uma viagem utilizando uma plataforma web.

25 responses



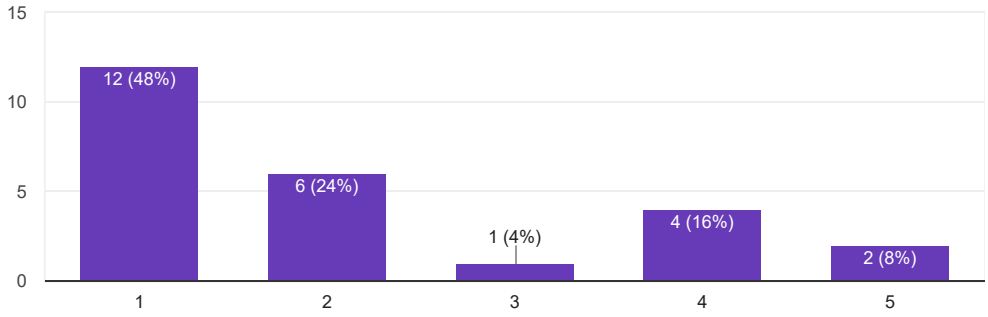
5. Achei as várias funções desta plataforma web, bem integradas entre si.

25 responses



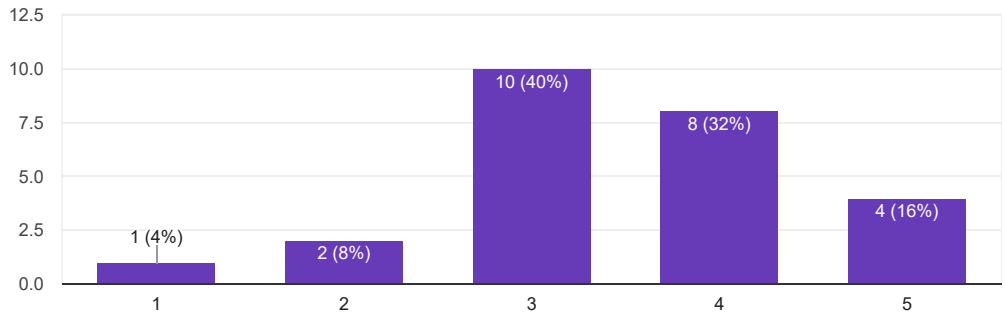
6. A plataforma web pareceu-me bastante inconsistente.

25 responses



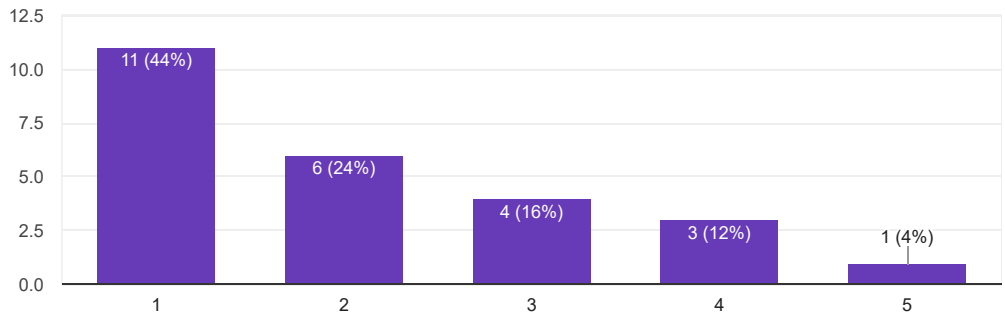
7. Penso que a maioria das pessoas, conseguiria facilmente reservar uma viagem utilizando uma plataforma web.

25 responses



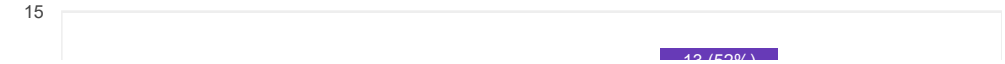
8. Achei a plataforma web bastante complicado de utilizar.

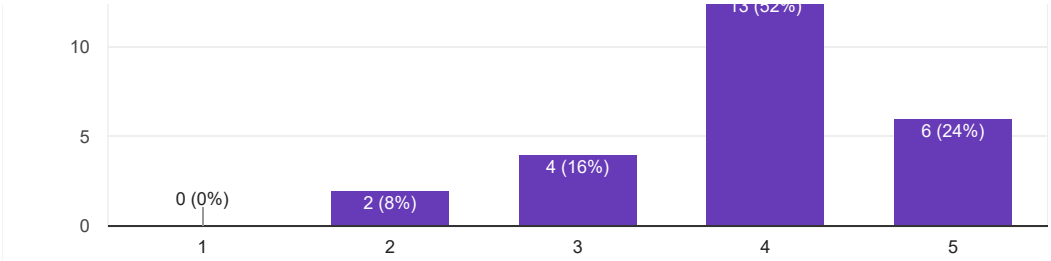
25 responses



9. Sinto-me seguro e confiante a utilizar uma plataforma web para reservar as minhas viagens.

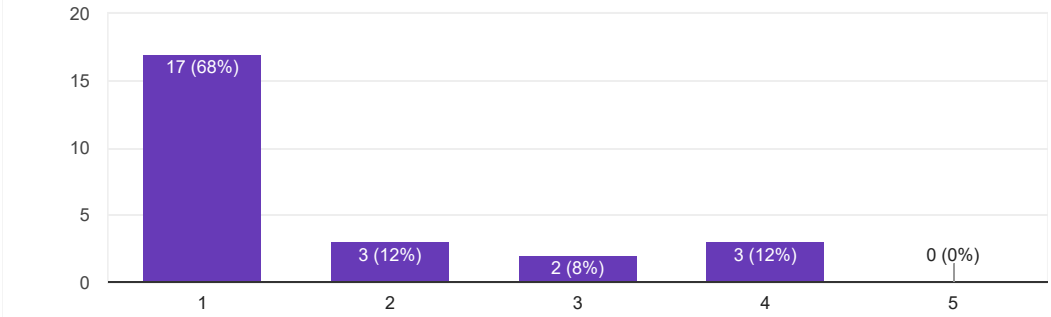
25 responses





10. Precisei de aprender coisas novas para saber utilizar esta plataforma web.

25 responses



Conclusão

Com que opinião ficou acerca de recorrer a um chatbot para reservar uma viagem? (Opcional)

20 responses

Acho que um chatbot é um conceito interessante e viável para a marcação de viagens. Contudo, pessoalmento, prefiro usar uma página do que ir recebendo opções num chat.

O chatbot parece ser mais simples de utilizar que as plataformas web.

Prefiro o modo tradicional

Actualmente, e tendo os meus conhecimentos, prefiro ser eu a marcar a minha viagem usando plataformas web. Na minha opiniao o uso de chatbots vai limitar a visualizaçao das opçoes dos utilizadores.

Futuramente espero que uma maior integraçao das plataformas com um chatbots vai facilitar o seu uso. Tambem com o treino dos algoritmos novas abordagens ou formas de representaçao e cruzamento de informaçao vao aparecer, mas a falta de sensaçao de controlo vai estar presente o que para mim vai ser uma barreira a ultrapassar.

Um chatbot para reserva de viagem torna-se mais pessoal e acho que muita gente optaria por este método para reserva das suas viagens.

Acho que o Chatbot oferece menos flexibilidade em escolhas mais complexas. No entanto, para utilizadores com dificuldades na utilização de tecnologias, pode ser uma alternativa mais fácil de utilizar, uma vez que apenas necessitam de uma interacção básica, ao nível da linguagem.

É uma solução interessante na medida em que é fácil visualizar as opçoes e não aparece a habitual lista imensa de resultados.

Acho que no futuro as plataformas web tal como são hoje vão desaparecer em favor dos bots. O bot é muito mais intuitivo e pratico.

Uma ideia bastante interessante e com futuro.

Parece-me uma boa opção para o futuro.

Boa

Parece interessante e seguro

Penso ser uma otima ideia recorrer a um chatbot

util

Pareceu mais simples , due mais confiança menos complicado

uma forma pratica de marcar uma viagem sem esquecer as necessidades basicas.

Parece util

as opçoes apresentadas parecem ser limitativas de uma boa escolha. seria de ter a opão de se procurarem outras possibilidades, sobretudo hoteis e carros de aluguer. para os voos muito bom!

Parece ser um processo equivalente aos existentes mas mais objetivo e simplificado.

BOA PARA PESSOAS IDOSAS

Tempos Chatbot	Tempos Expedia
03:13:00	02:02:00
02:49:00	01:59:00
02:18:00	02:15:00
02:35:00	02:29:00
02:49:00	02:22:00
03:16:00	02:35:00
02:25:00	02:04:00
03:51:00	02:16:00
03:06:00	01:48:00
02:54:00	03:10:00
04:00:00	02:40:00
03:04:00	02:13:00
02:47:00	02:17:00
03:35:00	02:11:00
03:03:00	02:43:00
03:10:00	02:41:00
02:50:00	02:36:00
02:31:00	01:47:00
03:53:00	03:26:00
03:55:00	03:43:00
02:17:00	01:42:00
03:08:00	01:57:00
03:47:00	05:02:00
02:51:00	02:05:00
03:52:00	03:36:00

Figure A.1: Testing recorded times

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[28] System usability scale. https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html.

[29] Apple siri. https://www.apple.com/ios/siri/,.

[30] Google assistant. https://assistant.google.com/#?modal_active=none,.